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THE BRUSH-SWAN SYSTEM.

The Storage-Battery Made the Medium for Incandescence Lighting.

A DESCRIPTION OF A COMPLETE SYSTEM OF ELECTRICAL ILLUMINATION — CITIES, STREETS, STORES, PARKS, AND PRIVATE DWELLINGS LIGHTED BY ONE COMPANY, OR ITS LESSEES —THE FIRST ATTEMPTS AT INCANDESCENCE LIGHTING—THE WORK OF BRUSH—A PRACTICAL MAN WORKS AT THE PROBLEM—WHAT HAS ALREADY BEEN DONE BY THE BRUSH-SWAN COMPANY—LIGHTING A CITY BY THE POWER OF A RIVER RUNNING WITHIN ITS BOUNDARIES.

To the Brush Company belongs the honor of first introducing in practical working order a system of arc-lighting; and though this company was by no means the pioneer in the incandescence field, it succeeded, while others were yet experimenting, in finding a means by which incandescence lighting can be made reliable.

The Brush system is complete. It was devised by skillful electricians and practical men, not for the purpose of astonishing and delighting the audience in a college lecture-room, but for general illumination. By it the public thoroughfares may be rendered as bright as though the moon, forgetting to set, threw the effulgence of a never-waning orb unceasingly upon them. With its new combination of the incandescence light with that admirable contrivance, the storage battery, dwellings and offices may be furnished with a light which will not contaminate the atmosphere, and which not even the temporary stoppage of the engines that generate it will suffice to extinguish.

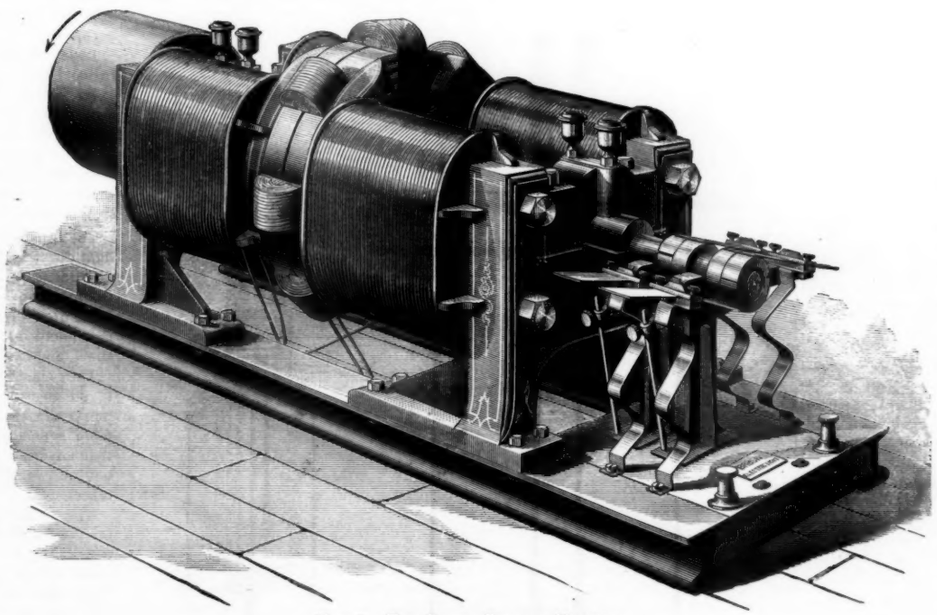


FIG. 1. THE BRUSH DYNAMO MACHINE.

This being the case, the Brush system cannot fail to be of more than ordinary interest, not only to the electrician and the projector, but especially to the manufacturer, who, by means of the same power which runs his shafting, may secure a more powerful light than gas, while at the same time greatly lessening the danger which the use of gas necessarily brings with it.

It is, therefore, with no little satisfaction that we present to the patrons of the New York ELECTRICAL REVIEW a complete and illustrated description of the Brush system, with all its recent improvements.

It must be said that the gratifying success which attends the workings of the Brush Company is as much due to the admirable management of the executive as to the skill of the electrician. From the very start the operations of the company were conducted on strict business principles. While some competing companies were promising to rival the sun and moon in the intensity of their light, the Brush Company wisely refrained from similar exaggerations, offering to furnish a plant which should for every horse-power developed generate only what amount of candle-power of intensity it had already abundantly demonstrated its ability to do. Care was taken, also, to put their plant only in the hands of men whose antecedents were a guarantee that they would engage only in a reputable enterprise. Thus the Brush Company, both here and abroad, has always borne a good name.

It is well known that parent companies not infrequently put their plants in the hands of projectors without troubling themselves to ascertain what are the reputations of their would-be lessees. For they believe that it concerns a dealer to measure his custom only so far as his ability to pay for the goods is concerned. Generally speaking, this is, of course, sound reasoning. The butcher and the baker sell their wares to whomsoever applies for them, never pausing to think of the use that is to be made of them.

But, where an expensive lighting plant of novel design is sold by a company, most people will agree that some care should be taken to ascertain the business standing of the purchasers, besides the fact that they are able to pay for it. Recent experience has shown that companies are often established with no other purpose than to sell stock at absurdly high prices to innocent persons, and though the parent company—the company that sells the plant—could not be legally held responsible for the swindle, it is a serious question if they be not, to a certain extent, morally responsible. It is certain that unscrupulous conduct on the part of the lessee or buyer, affects the reputation of the lessor or seller, and many a fair business reputation has been tarnished by the acts of those for whom a parent company was not legally responsible.

As said before, the high standing of the Brush Company to-day is due as much to the fact that it has used discrimination in its selection of lessees as to the excellence and efficiency of its apparatus.

The interposition of the storage battery in the Brush incandescent system will, there is reason to believe, save much time in the long-continued argument of the question whether it is more desirable to employ auto-exciting machines, or those whose field magnets receive their current from a separate source. In the first instance, we have the bobbin, electro-magnets, and external circuit of lamps, all in one direct circuit, and all dependent one upon the other. In the second case the bobbin and external circuit are entirely contained within themselves, the electro-magnets forming part of the circuit of the separate exciter. Taking the first kind of machine, and revolving it, at, say, 1,000 turns per minute, it gives us, through a definite external resistance, a certain strength of magnetism, and a stated intensity of current. These will continue constant as long as our speed and external resistance remain the same; but directly our external circuit varies in resistance, then the magnetism and current produced are immediately affected, and the machine tends either to pull up or run away in accordance with the diminution or increase of resistance. Therefore, at times when we require a greater strength of current to overcome our external resistance, we must necessarily be content with just the opposite.

When the electro-magnets of such machines are once wound with wire having a certain number of convolutions, and of a given resistance, we cannot alter their condition for the varying effects we may wish to produce. A machine of this class, then, may be much more efficient for one operation than for another, and the percentage of the total horse-power expended in a circuit, for magnetizing the electro-magnets, forms an important element in their construction.

Machines which have their field magnets excited from a source independent of that which produces the light have some advantages over those referred to, and, as one small exciter may be made to produce the current for magnetizing the field magnets of several light-giving machines at once, this method of working has, to a certain extent, grown in favor in this country.

If the external resistance of a circuit increased, the speed of the machine would slightly increase, and, as the magnetism is derived from another and approximately constant source, we should develop higher electro motive force to overcome our increased external resistance.

We need not concern ourselves so much with the size of wire and the convolutions put on the electro-magnets when using a separate exciter, as there is no external variation of resistance to affect the magnetism. We do not mean to say that this is a matter of indifference, but that it does not play such an important part in the construction of a machine as it does when the wires of the field magnets form a part of the whole circuit. The nearest approach we can have to a separate exciter is to employ our electro-magnets in a shunt circuit, but even then our magnetism varies with any change in the resistance of the lamp. The Brush machine is a good example of this system of using dynamo electric machines, but with this addition, that the field magnets are wound with both thick and thin wire, the one in the main and the other in the derived circuit, and both go to produce the necessary magnetism. One of the great drawbacks of the first-mentioned and simplest method of arranging a circuit is the inability of the machine to do a small amount of work.

For instance, a machine which will keep, say sixty incandescent lamps in operation, would fall entirely to work ten, as the external resistance in the latter case is so comparatively large that we could not produce sufficient current (owing to the low electro-motive force produced at the start from

residual magnetism) to bring up our magnetism to the necessary point. We might, of course, work ten, if we placed artificial resistances in the places of the fifty extinguished lamps; but then we waste 5-6ths of our power. If a moderate magnetic field could be provided and kept constant in a machine having its bobbin, electro-magnets, and external circuit in one, we should then get over the above difficulty. It is not improbable that a combination of permanent and electro-magnets will some day be employed to produce a greater electromotive force at the starting of the machine.

The Brush machine (Fig. 1) is admitted by eminent authority to be a very successful, if not the most successful modification of the Gramme machine.

The most striking feature of the Brush machine consists in the arrangement of the collectors and coils whereby each pair of the four pairs of coils is, in turn, cut out of the circuit during one-eighth of a revolution, so that there are only three pairs of coils in circuit at one time. The object in doing this is to get rid of the waste of energy necessitated by sending a current through one pair of coils during the time at which they are doing little good and cutting few lines of force. A little consideration will show that this is when the coils are very nearly at an angle of ninety degrees to the lines of force; for at this time the number of lines of force passing through these coils is at a maximum, but their rate of change at a minimum because the rate of change varies as the cosine of the angle.

There are two sets of brushes and four commutators—one commutator for each pair of coils. Each brush is made to touch the commutators of two pairs of coils, which are not contiguous, but at right angles to each other. The two strips of each commutator are separated from each other by about one-eighth of the circumference; so that, whenever these insulating spaces come under a brush, the pair of coils corresponding to this commutator are cut out of the circuit. Now, the brushes are so placed that they come over these insulating spaces just at the time when the coils corresponding are in the position of minimum action, and they come into contact with the strips of the commutator again when they are approaching a position of greater effectiveness.

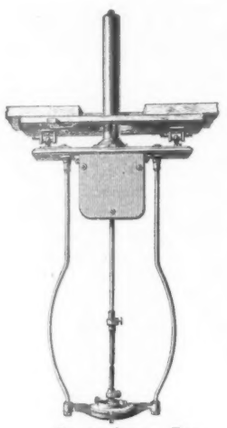
In this machine the four pairs of coils form four independent machines, the two coils of each machine being in series; but the four machines are joined in two pairs by the arrangement of the collector, the two machines thus formed being joined in series at the last, so as to generate one continuous current of high electro-motive force. Of the two machines thus joined in series, one has one pair of coils in the position of maximum effect, the other pair in the position of minimum effect, and therefore cut out. The other machine has both pairs of coils in circuit, and both in positions of medium effect. The current finally generated may therefore be said to be that of two machines joined in series—one machine having two coils in series in a position of maximum effect, the other machine being composed of two machines joined in parallel, each of these machines consisting of two coils joined in series and lying in positions of medium effect.

Low tension machines have not been a complete success in furnishing electricity from central stations for general illuminating purposes so far as the economical production of the light is concerned. The reasons are obvious: The external resistance or measure of efficiency of a circuit is continually lessened by adding to the number of lights, and to keep pace with the loss it is nece-sary to increase the size of the conductors. This involves an enormous expenditure for copper wires. In order to supply current economically, there should be as little resistance in the line as possible; that is, the conductors should absorb the least possible amount of current. As every foot of wire offers a certain amount of resistance to the passage of the current, the greater where quantity is sought to be passed, it is plain that at a certain distance from the generator this becomes a constantly increasing charge on the light. Dr. Siemens estimates that the cost of conductors to convey current from a low tension machine is six times as great as the cost of conductors to carry current from a high tension machine. The cost of maintenance is correspondingly great, being estimated to be three times as much in the amount of power required.

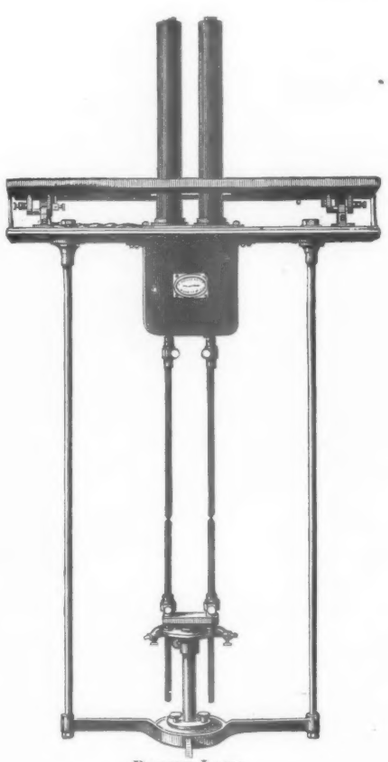
At the Paris Exhibition of Electricity, 450 Swan lamps were fed from Brush machines, and 120 Swan lamps from Siemens machines. The conductor from the Brush machines weighed one-half as much as the conductor from the Siemens machines, the lengths being equal; that is, to carry a low-tension current from a Siemens dynamo required a conductor nearly eight times as large as a conductor to carry a high tension current from a Brush machine.

WALL LAMP.

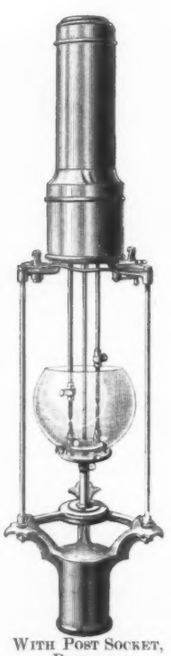
ORNAMENTAL LAMP.



SHORT SWELL ROD, SINGLE.



DOUBLE LAMP.



WITH POST SOCKET, DOUBLE.

Given an electric lighting plant of a certain capacity, capable of furnishing at the generator (with a low tension machine) nine lights to the horse-power, when the lines are extended into even the most limited area practicable for general illuminating purposes, the efficiency decreases to less than three lights to the horse-power as shown by actual experiment.

Given a plant of similar capacity, with a high tension machine like the Brush, and the loss due to resistance is reduced to less than one light in nine, so that it is possible to deliver more than eight lights to the horse-power at any point within the area to be lighted.

Here electricians are met with the most important problem of electric lighting from central stations.

In either of the above cases, to supply the maximum amount of light required at any moment the demand may be made, requires the maintenance of the maximum amount of power needed, and the installation of works of corresponding magnitude. The works may be almost idle during fifteen hours of the twenty-four, but they must be maintained just the same; for in the business of furnishing illumination for domestic purposes, a station must be able to supply light just as the gas works do, at any hour of the day or night when needed. A full force of attendants, an adequate supply of steam for emergencies (whether of unexpected cloudy days or misty mornings), and regulating apparatus that must involve more or less waste of current, are among the necessary requirements of such a system. It cannot be said that if at six o'clock ten thousand lights are running, and at ten o'clock but five thousand, the latter will cost half as much to operate; for nearly as much steam will be required, counting the load of the engines and the friction of bearings, while the cost of attendance remains the same.

The best informed electricians, understanding the great loss involved in such a system, have long since become convinced that electric lighting for domestic purposes, in order to be practical, must be aided by some method of conserving all, or nearly all, the energy created by the motive power, so that every revolution of the wheel of the engine may find useful expression in light or transmitted power. It became evident that such a system would greatly reduce the amount of plant required; would increase the amount of light per horse power, if delivered from a high tension machine, and utilize the full value of the services of attendants.

It was conceded that something must be had which in an electric lighting system, or in an electro-motive power system, would take the place represented by the gasometer in the gas lighting system and by the accumulator in a hydraulic power system. The battery which will do this is now provided, and the application of electric currents will probably make more rapid advance from this time than it has done even within the past four years. The new battery may be made to meet any requirements. It may be of small size to go into the place of the gas meter in a house, or in large tanks for extensive public buildings. With such a battery, a high current machine may be used to deliver a high tension current, at almost any distance from the generator, to the point where the electricity is demanded, and the current having been discharged into the reservoir, with scarcely a perceptible loss in transmission, its full value can be obtained when drawn from the battery where chemical action converts it to current of low tension, and the light can thus be produced at a minimum cost.

The business of the Brush-Swan Electric Light Company is to grant or sell State, city or town rights for the formation of companies in the territory not yet disposed of.

To sell electric lighting plants to manufacturing and other companies and individuals.

To furnish all supplies to plant owners, exclusively.

Many thousands of lamps are already in operation in the company's territory, which is coterminous with the United States as to the Swan lamp, and the same east of 77° long. as to the Brush system.

The Brush Company claim that the arc light direct from the Brush dynamo-electric machine, and the Swan incandescence light, from the Brush storage battery, combine to make up a perfect system for commercial, manufacturing, domestic, church, theater, street, and marine coast lighting.

They claim that it is the most economical of all electric lighting systems both as to power and cost; that the fact that it is far more generally used in the United States than any other system, proves, they say, and not unreasonably, that it is preferred to all others.

The Brush Company claims that no other arc system gives an equal amount of light or distribution for a like cost of plant; that no other system gives as great a number of lights or degree of effectiveness to one dynamo; that no other system has storage batteries, hence cannot utilize its plant out of lighting time or the wasted energy of "cut-out" lamps; that no other system gives light at so small a cost of plant per lamp; that no other system gives eighty arc nor 2,400 incandescent lights per day, nor, in the aggregate, even an approximate amount of light from one dynamo; that no other system can work as economically over long circuits as the Brush system.

Up to the advent of the Brush incandescence system, all incandescence lighting in this country has been done direct from dynamo machines, and the system, if the reports that come in may be relied upon, would seem to be somewhat costly. This has, undoubtedly, militated against the rapid introduction of this light both for isolated lighting and for lighting from central distributing stations; and there is certainly a great demand for a system in which the difficulties now prevailing can be eliminated.

Machines furnishing a quantity current such as have been used for this purpose, instead of intensity, which the Brush Company is now using, have been in a certain measure unable to overcome economically the resistance in long circuits, and have by no means given satisfaction, save for continuous use in limited areas.

The British Company believe that, with their present system they can furnish incandescence lighting both easily, and, above all, economically.

The Brush system of arc lighting has been adopted by many cities and towns in this country. The grandest avenue in New York, Fifth avenue, is lighted by it, and Union and Madison Squares, each covering a large area, are brilliantly illuminated by a description of iron tubular lighting towers, which constitute a distinctive feature of the Brush system. [See drawings on first page.]

Following will be found a list of the cities in the United States where these lighting towers have been erected by the Brush company's lessees, together with their number and heights:

Cities.	Number of towers.	Height.
Evansville, Ind.	10	100
Aurora	6	150
Fargo	1	150
Denver	6	150
Fairfield	1	150
Topeka	1	175
Bay City	1	22
Rock Island	11	14
Macon	9	150
Tipton, Ia.	1	150
Savannah	12	15
Fond-du-Lac	6	150
LaCrosse	4	150

Cleveland, O.; Wabash, Ind.; and Akron, O., have each towers of 250 feet, while St. Paul has one 275 feet.

With ten towers, each 100 feet high, the local Brush company—a lessee of the Brush company—contracted, some time since, to light up the city of Evansville, Ind., the contract being for five years, at $16,000 per year. The means by which this was accomplished is commendable by reason of its success and efficiency.

The ten towers now in use are 100 feet in height, and may be described as skeleton frames, triangular in cross sections, composed of tubing, a section connected by special couplings of malleable iron, and trussed by wrought iron rods diagonally. The tubular sections of the posts or standards are eight feet in length. The size of the pipe used for the standards and girts are properly proportioned to resist the estimated strain upon the several points. Each tower is furnished with an elevator, by means of which the attendant can raise and lower himself for the removal of carbons and repairs to the lamps when needed. The bases of the towers are securely anchored to heavy piers of stone work, and they are guaranteed to withstand any and all storms that are not generally destructive to surrounding property. In addition, the towers are also furnished with patent malleable iron steps, clasped upon one of the standards, thus forming a ladder from bottom to top of them. Each tower is surmounted with four lamps, each with 2,000 candle-power, giving a total light in strength of 8,000 candle-power, and when lighted, displaying to their fullest extent their graceful and ornamental style of architecture.

Each tower is furnished with four lamps, each lamp having 2,000 candle-power.

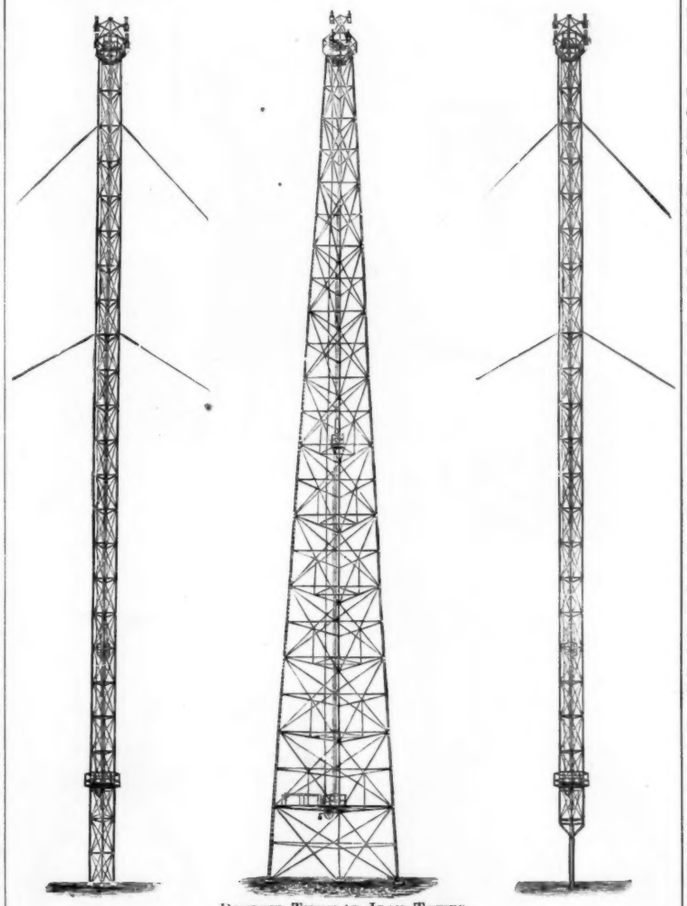
The united effect of these great sun lamps is novel and impressive, the districts immediately adjacent to the towers being bathed in splendor, while a suburban ride of five-eighths of a mile beyond the outside towers realized a light as clear as full summer moonlight lying abroad on the dark fields and lonely outskirts of the city.

In the immediate vicinity of the towers the light is very brilliant, and the shadows formed are very sharply defined. As you go from the light towards a shadow it appears to be dark beyond, but on arriving at the shadow the light is still perfect, though not so strong. As the light in its intensity and power, like that of the sun acting upon the unprotected eyes, is painful to a steady gaze, the advantage of the elevated system is at once seen. The arc light is somewhat modified by the use of shades, but the effect is produced at a reduced percentage of light; the result being an excessive illumination in the immediate vicinity of the lamps, and a less perfect illumination a short distance from them.

The station of the Evansville Brush Electric Light and Power Company is situated on Division street, just to the right of Main street, and between that thoroughfare and the freight depot of the Air Line Road. The building is of fine pressed brick, 127x49 feet, having a fire room of 42x48 feet, an engine room 25x48 feet, and the dynamo machine room 53x48 feet. The engines and machinery are first-class in every respect, the best that modern mechanical and electrical engineering could design. The boilers are 18 feet long by 5 feet in diameter, of the horizontal tubular type, and are nominally of one hundred and fifty horse-power each. They are supplied with city water by a direct acting steam pump; there is also a large iron tank kept filled in case any accident should happen to the city's water works; and in case this should be exhausted before the accident could be remedied, there is a large steam pump drawing water from a well driven beneath the fire-room floor. There is in addition to this, a spare steam pump for feeding the boilers. The piping is so arranged that they can be supplied direct from the city mains, from the tank, or from either feed pump. The motive power consists of two automatic "Cummer" engines rated at 125 horse-power, but will work up to 175 each, cylinders 14 inches in diameter, by 30 inches stroke. The band wheels are 12 feet in diameter by 24 inches face, and run at 110 revolutions per minute, steadily and almost noiselessly.

By an arrangement of clutch pulleys, either one or both engines, may be run as occasion may require. There are six dynamo electrical machines in operation, and another will soon be added. These machines and all the electrical apparatus are manufactured under the Brush patents by the Brush Electric Company, of Cleveland, Ohio, and include both generator and regulator peculiar to themselves, and may therefore be looked upon as complete in themselves, differing in that respect from all those so-called systems which are represented by either a particular form of machine or a special arrangement of lamp. They manufacture their own carbons, making the whole installation still more peculiar to themselves.

These machines are the same as are used so extensively, not only in this country, but throughout England, the continent of Europe, India, Mexico, South America, China, Japan, and in fact nearly all over the world. Two of the machines have a capacity of 20 lights of 4,000 candle power each. One of 5, 4,000 candle power lamps, one of twelve lamps of 2,000 candle power each, one of sixteen lamps of 2,000 candle power each, and one running forty lamps of 2,000 candle power each, making in all a lighting capacity of 216,000 candles power, considerable of a difference in power as displayed by the lightning bugs at the street corners. There are four metallic circuits or loops of heavily insulated wire running from the generating machines in the station to the lamps in different parts of the city. This wire is of pure copper, and weighs altogether over four tons, and is nearly twenty miles in length.



Detroit Tubular Iron Tower.

After nearly a year's experience with the lights, there have been no fires, no loss of life, or even any one slightly injured. The station is supplied with a complete testing apparatus, which enables the electrician to determine at any time during the day or night the condition of all wires outside the station. The machines have a connection with an automatic current governor, which controls them in such a manner that they will generate just enough electricity for the number of lamps in use in the circuit. The lamps are of the regulating order, designed by Mr. Brush, and are quite as much an element of the success of his system of electric lighting as are the machines themselves; and while their performance is surpassed by no other regulator, and although they contain special contrivances to enable them to maintain a steady arc when burning sixteen or more together in a single circuit, they are probably the simplest in construction of all our regulators, involving no clock work or complicated feeding mechanism, or indeed anything that is liable to become deranged.

They can be constructed to burn continuously for eight, sixteen, twenty-four, or, indeed, for any desired number of hours, and the mere hanging of a lamp in its place puts it thereby into the circuit of the other lamps of the series. The lamps are of the double carbon, or sixteen-hour order, and, like most of the modern electric lamps, the upper carbon descends by its own weight until it touches the lower carbon, and the circuit is thereby completed.

The carbon pencils consumed under the Brush system are, before being used, a foot long, and are electro-plated with a thin covering of copper; they last about eight hours, during which time about 9½ inches of the positive and about 4 inches of the negative carbon are consumed. When, however, the lamps are required to burn for a longer period, double carbon lamps are employed, fitted with two pairs of carbon holders.

The change from the one pair of carbons to the new pair is effected by purely mechanical means, and by a contrivance the ingenuity of which is only measurable by its extreme simplicity.

The lamps are all provided with a simple switch, which enables them to be turned off or on as occasion may require. They are fitted with an automatic cut-out which, in case of accident to any one lamp, cuts out at once from the current the faulty lamp without disturbing the working of the remainder.

If only large areas could be economically lighted by the electric light, it would surely fall far short of that which had been promised for it. We know that much of the disease which obtains in large cities comes more from an infected atmosphere than from badly ventilated rooms. No one will deny that illuminating gases are poisonous. Some work quicker than others, because some contain more carbonic oxide—which is a deadly poison—than others.

Several years ago the public was told that they should have incandescence light, a light which was very truly described to them as containing nothing that could in any way affect the health. Since it burns, or rather glows, in a vacuum it cannot touch the air at all and cannot, therefore, like illuminating gas, throw off a continual stream of sulphur and other fumes.

The announcement that incandescence lighting was at hand, was naturally enough very gratifying to the public. But the date of its appearance went by, and yet it did not come; months, indeed years, passed and little progress toward a practicable system was made. In the great city of New York, a small section was and is lighted with incandescence; but the question as to its economy when compared with gas, is yet, it is safe to say, more than doubtful.

Professor Brush, without making any rash promises, made a careful study of the situation. Instead of puzzling over present systems, he struck out into an original field, and there is good evidence to show that he has solved the problem.

The storage battery, that wonderful contrivance, was being used for all sorts of interesting scientific experiments, but little practical use, when he determined to make it an important adjunct in the problem of incandescence lighting. The storage battery, as changed and adapted by him for incandescence lighting, would seem to be the missing link that was needed.

Mr. Brush says his accumulator is a perfect invention and not an experiment, and the company has erected a new plant at large cost, which requires about 1,500 horse-power, solely for this branch of its business. This battery is protected by patents granted to Mr. Brush and controlled by the Brush company. It is said of it, that it will not depreciate in value more than five per cent. per year; that during the first year or so it will improve with use, and after that remain prac-

tically constant with very slight attention, that for every horse-power absorbed by the dynamo machine used in charging the battery, the battery will deliver eight lights in Swan lamps equal to Edison's "A" lamps in power.

The storage batteries invented and completed by Brush are composed of a number of cells containing cast lead plates of a peculiar construction, chemically prepared by Mr. Brush's process, immersed in a solution of sulphuric acid. These cells may be connected together so as to produce any desired result, either in quantity or intensity of current. When placed in circuit with a Brush dynamo machine, the electricity generated is accumulated in the battery and may be used at pleasure.

It is the business of the Brush-Swan Companies to place these storage batteries in any convenient location on premises of consumers of light, and connect them by wires with the central station or place where electricity is generated. A large number of these batteries can be placed in one circuit, and be supplied with electricity from one generator.

Where dynamo machines have already been provided for running arc lights, either by lighting companies, individuals or firms, they can be used at any time when not required for the arc lights to charge the storage batteries.

An automatic current manipulator or switch is provided with each battery, and is so arranged as to retain the battery in circuit until it is fully charged and then disconnects it from the circuit. When the charge has been exhausted down to a certain point, it brings it into circuit again and holds it till it has been recharged and then cuts it out as before. The same operation is repeated with every battery in circuit. The entire operation is automatic, requiring no attention after being properly adjusted.

Each battery has a meter attached which registers the exact amount of electricity stored.

The incandescent lamps are connected with the storage batteries by wires hidden from sight, and may be used at any time, even while the battery is receiving its charge from the central station.

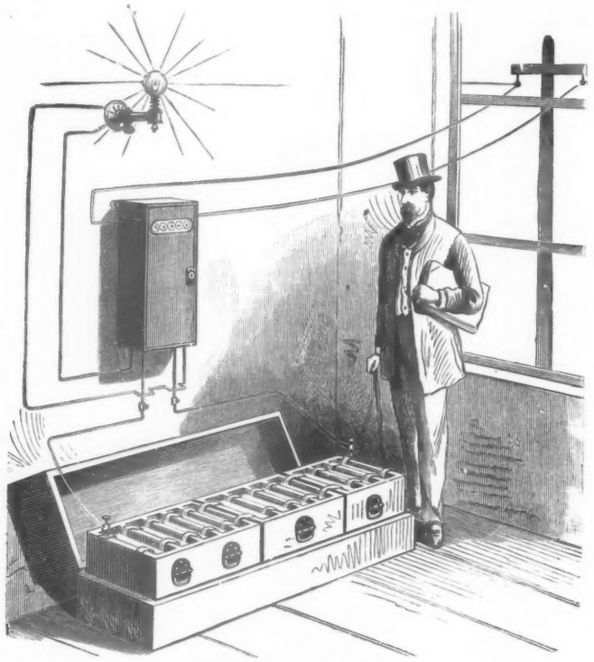
The quantity of electricity capable of being stored in the Brush storage batteries may be increased to any amount by increasing the number of cells and the size of the plates.

It will thus be seen that the dynamo may be made to do double duty, storing electricity by day for use in connection with the Swan incandescent lamps and supplying Brush arc lamps direct, at night.

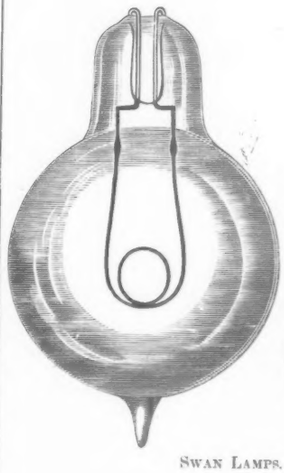
At present the storage batteries are adapted to and used in connection with the Incandescent lamp only, but may be made equally available for the transmission of power.

The Brush Electric Company guarantee that the batteries will increase in efficiency during the first year, and not cost more than five per cent. per annum to maintain them at their full efficiency.

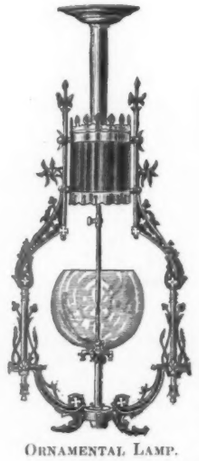
A large cotton mill, such as the Pacific Mills at Lawrence, Mass., the Merrimac Mills at Lowell, or any establishment of similar size, if lighted by incandescence lamps, would require a very large number of them, probably ten thousand, to replace a similar number of gas burners. The light would be needed only on an average of one hour per day, or about three hundred per year, no light being required in Summer time. An electrical apparatus capable of producing this amount of light direct from the dynamo, without the intervention of storage batteries would have to be of very large size and would cost a large amount. It would require for its operation not less than one thousand horse-power of engines and boilers, and all accessories of a complete power plant. This enormous plant would all have to be provided and kept in perfect working order during the entire year, but would only be actually used during the three hundred hours of the year that the light was needed; it would therefore be a non-productive investment during 8,460 out of the 8,760 hours in the year. And in addition to this great loss there would be a loss of fuel in starting the fire under the boilers before the time of lighting to get up steam, and a corresponding waste of fuel after the light was no longer required before the fire died out. With the introduction of storage batteries all this would be changed, the investment for the incandescent lamps and wires would be substantially the same as in the first instance; but an electrical apparatus would be needed only large enough to furnish and store up, or accumulate, an amount of electricity in the hours when no light was required sufficient to run the incandesent lamps for the remaining hours when actually needed. In other words, other things being equal, an electric generator used in connection with storage batteries, and a power plant to drive it, would not need to be more than one-tenth of the cost of the plant first described.



BRUSH STORAGE BATTERY.



SWAN LAMPS.



ORNAMENTAL LAMP.

It would be a question of furnishing, keeping in order, and running one thousand horse-power in one case for three hundred hours in the year, against say, forty or fifty horse-power for the entire year, or to meet extra demands for longer hours, a maximum capacity of, say, one hundred and twenty horse-power. Most mills could spare the smaller amount of power without noticing it, and could operate the plant at a very small cost. The great saving would be in the first cost, interest and wear and tear. An item of importance also, in comparing the two systems, would be in the absolute steadiness of the light furnished by the storage batteries, which cannot be equaled by lights running direct from a machine driven by the most perfect running engine in existence.

Insulation Resistance and Electric Lighting.

We were recently asked, in all seriousness, whether we should regard an insulation resistance of 1,000 ohms per mile as sufficient for leads used for ordinary incandescence lighting, and from several other circumstances which have lately come to our knowledge, we are led to believe that, even now, this subject is but imperfectly understood by many electric light engineers and contractors. With the one exception of Mr. Fletcher Moulton's Provisional Orders for electric lighting, where he gives as a sort of standard, an insulation resistance of 5,000 ohms per *volt*, which, however, is meaningless, we cannot at the moment call to mind any instance whereby an electric light contractor can obtain any figures on which to base his estimates. The rules issued by the Society of Telegraph Engineers and Electricians last year, contain only the vague remark that "the wires should be efficiently insulated." Mr. Heaphy's well-known compilation which he drew up for the Phœnix Fire Insurance Office, gives but the fact that "all wires should be thoroughly well insulated with a material rendered as non-inflammable as possible." Mr. Robert Sabine, in his paper on "Electric Light Leads," published in the ELECTRICAL REVIEW for January 6th of the present year, which article might be read and re-read with advantage, says: "In the judicious choice of an insulating material much of the success or failure of an electric lighting system may depend," and he concludes that vulcanized India-rubber is perhaps the best material at present employed, because it is specifically so good an insulator that a comparatively thin coating is sufficient if mechanically perfect. It is at the same time diathermanous and it is not injured by an accidental heating up to the boiling point of water. A conductor covered but lightly with vulcanized India-rubber, would give an insulation resistance of at least 100 megohms per mile at an ordinary, and, wherever dampness and moisture could affect the lead, we would in no case recommend a less insulation than this even for electromotive forces below 100 volts. For perfectly dry places, 20 to 30 megohms per mile might suffice, and such an insulation resistance as this can, of course, be obtained by the employment of inferior material. As we have always noticed a tendency on the part of electric light contractors to reduce the insulation resistance of leads as they get smaller, as, for instance, the conductors running through electroliers, we may at once say that these are quite as important as the mains. Indeed, their insulation should be more particularly studied, for they cannot be so well protected mechanically as larger leads, and therefore they are much more liable to be the cause of short circuiting in an electric light installation, owing to their fragile nature and the bending they are usually subjected to. The covering of wires should not merely be looked upon from an electrical, but also from a mechanical point of view, for a good lead shou'd be capable of withstanding uninjured, bending, pulling, straining, or any other sudden shock. We think that contractors are sometimes misled by a mistaken notion of conductivity and insulation resistance. A person learns that a certain size of lead has a conductor resistance of one ohm, and an insulation resistance of one meghom, per mile, respectively. He thinks that one megohm is a very high resistance, amply sufficient for his purpose, and he selects this particular lead for his installation. He employs, say at least, 10 miles of wire, and overlooks the fact that while his copper resistance increases as the length of lead used, his insulation is going down in the same proportion, and that when his work is completed the insulation resistance of the whole circuit is only $\frac{1}{10}$th of a megohm. If some rules were framed showing the minimum amount of insulation resistance per mile to be employed for different degrees of electromotive force, we feel sure that much of the uncertainty which now appears to exist would be swept away, and we should have fewer complaints of electric-light installations breaking down. For machines producing alternating currents, modified regulations would be necessary, higher insulation being required.—*Electrical Review* (*London*).

A correspondent at Norfolk, Va., says that the electric light has at last supplanted gas at that point. The following action on the subject was recently taken by the City Council there:

Resolved, That the Councils, having received the report of the Committee on Light, and considered the various bids of the sundry parties proposing to light the city, do consider that the proposal of the Brush-Swan Electric Light Company, specified as No. 2 in the proposals of said company, is the best for the interests of the city, to wit: to erect and keep in order one hundred and twenty lamps to light the entire city during the same calendar hours as now provided by ordinance, when the moon is not clearly shining, for the sum of $11,900; and also the public buildings for the sum of $7,500 for twelve months; and the distribution of the lamps and the illumination of the city under the contract to be carried into effect in good faith during the continuation of the contract to the satisfaction of the Councils; and the Committee on Lights is hereby authorized and empowered to make the contract with the Brush-Swan Electric Light Company, according to the terms of their proposal No. 2, for the term of one year, to take effect within sixty days after the passage of the resolution.

Which was passed.

The Worcester, Mass., Electric Light Company Fully Organized—A Very Strong Board of Directors and a Solid Financial Backing.

The final organization of the new Worcester Electric Light Company was perfected on Monday last, with an exceedingly strong board of directors, comprising some of the leading bankers, merchants and manufacturers of the city. The company is organized under the laws of the State of Massachusetts, with a paid-in capital stock of $100,000, and all the legal formalities of incorporation have been fully complied with. The corporators are Messrs. Thomas M. Rogers, Loring Coes, and Theodore C. Bates, directors of the City National Bank; Hon. S. E. Hildreth, mayor of the city; Gen. A. B. R. Sprague, high sheriff of the county; Josiah Pickett, postmaster of the city; Hon. Stephen Salisbury, president of the Worcester county institution for savings; Lyman Brooks, agent of the Boston and Albany railroad; J. F. Adams, general freight agent of the Boston, Barre and Gardner railroad; H. H. Marshall, of the last named corporation; Charles B. Whiting, banker; William A. Denholm, of Denholm & McKay; Sumner Pratt, of Sumner Pratt & Company; Otis E. Putnam, of Barnes, Sumner & Co.; E. D. Buffington, and N. S. Liscomb, merchants; and Samuel Winslow, manufacturer of the Winslow skates. The new company has voted to purchase at once the 200-light Thomson-Houston plant and central lighting station lately completed by the American electric and illuminating company of Boston, and which Spencer Borden, Esq., general manager for New England of the Edison incandescent system, pronounces the best and most perfectly equipped electric light station he has ever seen. The company has also arranged to introduce the incandescent system for interior lighting, and has already a 20-light Edison machine supplying light for the works of the Worcester corset company. The corporators completed their organization last night by electing the following named gentlemen a board of directors: Thomas M. Rogers, Theodore C. Bates, Loring Coes, William A. Denholm, Samuel E. Hildreth, Nathaniel S. Liscomb, Charles B. Whiting, Josiah Pickett, A. B. R. Sprague, Stephen Salisbury, Jr., and Samuel Winslow. The directors have chosen Mr. Rogers president, and Mr. Whiting clerk and treasurer. The Company starts off with a fine established business and every prospect of prosperity.

Proposed International Conference of Electricians to be Held in Philadelphia.

In connection with the International Electrical Exhibition to be held in September next under the auspices of the Franklin Institute of Philadelphia, it is now proposed to hold an international congress at which the problems of electricity shall be scientifically discussed by men of acknowledged ability and position. To this end Congressman Mutchler, of Pennsylvania, is about to introduce a bill authorizing the appointment by the President of a scientific commission to arrange for the congress of electricians.

The congress or conference is to be not only for discussion but for the practical furtherance of electrical science by experiment and investigation. It will be in no sense an appendage of the exhibition which is to be made under the auspices of the Franklin Institute, although the two will naturally be in close relations. As to the exhibition, there has been already a considerable amount of interest shown, and everything seems favorable for a successful step in the direction proposed. The success of the Paris and Vienna expositions affords good grounds for believing that the one in Philadelphia will be also successful.

In the congress which is proposed to continue the work of the Congress of Paris and the Conference in Vienna, it is expected that the science will be materially advanced and that substantial results will be attained. The movement looking to its creation is supported by Professor Rowland, of the Mark Hopkins University of Baltimore; Professor Trowbridge, of Harvard University; Professor Snyder, of the Central High School Observatory of Philadelphia, and Professor Alexander Graham Bell, of Washington. It is believed that if Mr. Mutchler's bill shall pass, and the proper impetus be thus given by the government, nothing is likely to thwart the enterprise.

Electric Light for Chelsea and East Boston.

A meeting of citizens of Chelsea assembled in the parlors of the City Hotel last Saturday, for the purpose of consulting upon a plan for supplying Chelsea and East Boston with the electric light, and with a view of forming a local company. Several gentlemen connected with Boston and outside companies addressed those present on the subject, who advocated the Thomson-Houston system of arc lighting for the places named.

Brush-Swan Lamps.—Arc and Incandescent.

Permanency of the Electric Light.

So confident have an engineering firm in Glasgow, Scotland, become in the belief that electricity is to supply the light of the future—in large establishments, at least—that they have not caused a single foot of gas-pipe to be laid in the new building they have erected for carrying on their business.

A new and brilliant electric headlight for locomotives is being quietly perfected by a modest inventor of Indianapolis, who does not care to have his name made known until a public exhibition has placed it beyond the possibility of failure. The light will equal the light of 4,000 candles. At present a twenty-candle light is the best that can be produced. It will light the track for a mile, brilliantly, and the light will be full and continuous. The generator or dynamo will be run by steam at the will of the engineer. It will be located opposite the air-brake and will not take up as much room. By the same machine depots, bridges, cross-ings and tunnels will be lighted. Extending along the track for a half a mile in both directions will be an electric wire connected with the lamps in tunnels and bridges; then extending downward from the dynamo on the engine, the brush will be arranged to touch the wire as soon as it is reached. This will light up the object ahead, and as soon as the brush leaves the wire on the other side the light goes out. A public exhibition will be given soon.

Conductivity of Lightning Rods.

While Mr. Preece has announced that there is no difference in the conducting power of lightning rods, *Wieder's Annalen* states: "Holtz has concluded that solid steel bars do not form so good permanent magnets as tubes, because the core acts as an armature joining the two poles. In experimenting to test his hypothesis, he magnetized rods and tubes to saturation, and saw that the magnetism of the tube gave an excess of more than 50 per cent. After waiting for six months, he subjected the same magnets to new tests, in order to discover which retained the magnetism best. He found that the magnetism of the solid was to that of the hollow magnets in one case as 1:2.5 and in another as 1:2.9."

The Electric Light on the Railway.

Electric lighting of trains has been introduced on the Vienna and Trieste Railroad. So long as the speed is about 37 miles an hour the illumination is good, steady, and efficient, but whenever it falls to 17 miles the light is not satisfactory, notwithstanding the connection of accumulators with the lamps. It would seem, however, that what measurable degree of failure there may be when the train climbs up the steep slopes of the Semmering, between the stations of Gloggnitz and Murzzuschlag, is simply a matter of easily remedied detail.

A New Electric Motor for Sewing Machines.

An office has been opened in this city for the sale of a new sewing machine motor, made under the patents of Mr. L. W. Stockwell, of Cleveland, Ohio. This motor has been attracting much attention in Cleveland, especially at the office of the Leslie Sewing Machine Company, where it was shown running Leslie machines at a high rate of speed. This motor is manufactured by the Cleveland Electric Motor Company, and in the short time it has been before the public it has achieved a wonderful success. We learn that a large factory is being established and equipped in Cleveland, after the style of sewing machine factories, so that the motors can be turned out in sufficient quantities to meet the anticipated demand.

These motors may be run by battery, or direct from either arc or incandescent light wires. At the company's branch office in this city there are several sewing machines, a Sturtevant blower, and a printing press driven by these motors, the electric current being furnished by a Brush arc light wire from the street circuit. Each motor is furnished with a resistance box, by which the strength of the current, or the amount of it used, may be graduated to the requirements of the work being done. By means of a switch on this resistance box, connected with the treadle of the sewing machine, the machine may be started or stopped, or run at any speed from a few stitches per minute up to any rate the machine will stand without flying to pieces.

A New and Valuable Invention.

Mr. J. Elliott Smith, a prominent electrician of New York, has invented a machine which robs electricity of all its dangers. It is called a telegraphic and telephonic protector, and is intended to arrest and carry to the ground any extraordinary excess of current and thus prevent accidents. It was tested in New York on Wednesday.

The experiments were made by the superintendent of one of the companies who made use of a thirty-light dynamo machine. He grounded one end of a wire and ran the other end through a protector; thence from the protector to the telephone, and from the telephone to the ground. The current was then turned on. The protector automatically cut the wire and carried all surplus to the ground. The moment the surplus was taken off the circuit was completed, and the protector automatically readjusted itself. It is claimed that by means of the protector all danger at present attending the use of telephones and telegraphic instruments is removed.

Herr Krupp's great establishment at Essen has its own water and gas works. It contains 25,000 gas burners in addition to the electric lamps. It has its own chemical laboratory, photographic and lithographic establishments, and printing and binding shops. There are about 50 miles of telegraph wires and 35 telegraph stations belonging to the works.

A novel and interesting application of electricity has been introduced at the Court Opera at Vienna. The effect of swarms of fireflies flitting about a tropical forest is produced in a strikingly realistic manner, by the plan of suspending tiny incandescent lamps by fine swinging wires, the flashes of the artificial fireflies being caused by rapidly switching the current on and off.

Telephonic News

The New England Telephone Company and its Management.

The offices of the New England Telephone and Telegraph Company, 40 Pearl St., Boston, are rapidly advancing towards completion. The growth of the business has necessitated taking part of the second floor, and there are now in use three floors of the building.

The first floor is divided into offices, as below: President, Vice-President and Directors, Treasurer, Secretary and Auditor, General Manager, General Superintendent and Attorney, these offices being separated from the others.

On the same floor is the cashier's department, stock transfer clerk, stenographers, bookkeepers, etc , etc.; also the superintendent of the Boston district, which now includes all the territory formerly operated by the Suburban Telephone Company.

The next floor is occupied in part by the Private Line and Trunk Line department, a good size battery room, and quarters for the instrument setters, with large closets for their tools, etc., and shelves for bells, batteries, wire, etc. Here also repairs on instruments can be made.

A room for communication with subscribers and others within talking distance has also been fitted up on this floor.

The third floor is occupied by the exchange, which now numbers nearly twenty-six hundred and fifty subscribers, including those sending express orders. A separate system is maintained for this purpose, and an average of more than three thousand orders for expresses to call at subscribers' places are sent through daily.

The Gilliland fifty-wire board is used, but will shortly give way to the duplicate board of the Western Electric Company, with a capacity of four thousand wires.

Last, but not least, by any means, is the roof, on which is one of the finest towers in the telephone business. Here every wire is numbered where it enters, and goes to a lightning arrester; thence, by means of a number of office cables, which are fastened to the sides and roof of the tower, the wires enter a circular built contrivance, and then enter binding-posts arranged on a circular counter. Under this counter office cables connect with the different sections of switchboard below. By these arrangements any wire entering the exchange can be found in a moment, thereby saving valuable time in testing for trouble, etc.

Since the Lowell arrangement assumed control (about the middle of November) the exchange at Boston has made a net increase of almost two hundred subscribers, and it is expected that a gross amount of thirty-five hundred (3,500) subscribers will be reached before the new year. The offices located at the corner of Brimmer and Chestnut Streets, and at the Hotel Berkeley, Berkeley Street, are being rapidly consolidated into the new office on Tremont Street, and facilities are being made for a thousand subscribers at this office. In fact there appears to be no end to the telephone business in and around Boston. The officers of the company are: Theodore N. Vail, President; Wm. A. Ingham, Vice-Pre-ident; Wm. R. Driver, Treasurer; Chas. J. Glidden, Secretary and Auditor; Loren N. Downs, General Manager; Wm. H. Bent, Attorney; John T. Wheeler, General Superintendent.

Directors—W. H. Forbes, T. N. Vail, W. A. Ingham, Alex. Cochrane, C J. Glidden, J. E. Hudson. Fredk. Ayer, C. P. Bowditch, Stephen Salisbury, Jr.

The Chicago Telephone Company is just paying to its stockholders a special dividend of three (3) per cent.

Worcester Division, New England Telephone and Telegraph Company.

The cable to be used by the New England Telephone and Telegraph Company has arrived. It is about a mile in length, with 50 wires to a cable, and is to be strung in the principal streets. The company hope to have it put up next week.

The snows of last week, as well as the thunder-storm of Thursday, made a great deal of trouble with the wires, but under the direction of Local Manager Smith they were all in good order this morning.

It is now about four years since the two local exchanges in this city were consolidated. The Worcester circuit at that time had about 450 subscribers. At the present time there are 838 subscribers, while the Worcester division has 1,313 subscribers. At present there are 255 distinct wires entering the tower on the top of the building where the exchange is located.

The local exchanges in the Worcester division, and the number of stations in each, are as follows:

Worcester Circuit—Total number of subscribers, 838, as follows: Worcester City, 779; Cherry Valley, 4; Holden, 2; Jefferson, 3; Leicester, 10; West Upton, 2; Millbury, 22; Grafton, 5; Oxford, 2; Upton, 1; West Boylston, 2; Shrewsbury, 5.

South Framingham Circuit—Total number of subscribers, 73.

Natick Circuit—Total number of subscribers, 52.

Holliston Circuit—Total number of subscribers, 19.

Hopkinton Circuit—Total number of subscribers, 7.

Milford Circuit — Total number of subscribers, 66, as follows: Milford, 53; Hopedale, 6; West Medway, 3; Medway, 1; Uxbridge, 2; East Douglas, 1.

Walpole Circuit—Total number of subscribers, 55.

Spencer Circuit—Total number of subscribers, 60, as follows: Spencer, 49; East Brookfield, 11.

North Brookfield Circuit—Total number of subscribers, 37, as follows: North Brookfield, 19; Brookfield, 9; West Brookfield, 5; Warren, 3; West Warren, 1.

Southbridge Circuit—Total number of subscribers, 64, as follows: Southbridge, 51; Charlton, 3; Globe Village, 1; Sturbridge, 2; Fiskdale, 3; West Dudley, 1; East Brimfield, 1; Quinebang, Conn., 2.

Princeton Circuit—Number of subscribers, 2.

Westborough Circuit—Total number of subscribers, 11, as follows, Westborough, 6; Northborough, 5.

Webster Circuit—Total number of subscribers, 33, as follows: Webster, 30; Dudley, 2; Quinebang, Conn., 1.

The following towns in Worcester County, not in the Worcester division, are connected by telephone with the New England Telephone and Telegraph Company: Winchendon, Athol, Gardner, Templeton, Phillipston, Petersham, Westminster, Fitchburg, Leominster, Lunenburg, Lancaster, Harvard, Clinton and Sterling.

Kansas City and Northwestern News.

KANSAS CITY, Dec 27, 1883.

The damage done to the Denver Telephone Exchange by the recent heavy snow-storm was greatly exaggerated in the newspaper accounts. The damage was to only two of the main lines, and was caused by the snow falling and freezing, and by the heavy wind that prevailed. Subscribers were more or less annoyed for a few days, but the telephone men worked diligently, and soon had the broken lines properly connected. A recent sleet and snow-storm in this city caused the company some apprehension regarding the heavy cables, but the suspension wires were equal to the occasion. The only damage to the telephone company was about a half-dozen wires that broke under the strain. The Western Union Company suffered considerably more, one of their main lines, extending across the Missouri River Bridge, being broken down. The wires were soon put up, and but slight delay resulted.

The Pacific Mutual Telegraph Company, lately organized in this State, reports an excellent business. Geo. M. Meyers, general manager, states that he expects to have connection with about five hundred more offices within a week, connecting with the lines of the St. Louis and Texas Railway.

The annual meeting of the stockholders of the Missouri and Kansas Telephone Company and the United Telephone Company will be held at the office of the secretary, in this city, January 23.

A Kansas City gentleman made his wife a present of a telephone. He will be pronounced a most sensible man in telephone circles.

The Home Signal Telegraph Company presented all its messenger boys with a silver dollar Christmas morning. It took sixty of the "cases" to go around.

W. W. Cozine, of St. Joe, Mo., has been appointed chief operator of the Kansas City Telephone Exchange. BI-POLAR.

The Extension of the Telephone System Brings Several Minnesota Towns Within Speaking Distance of St. Paul and Minneapolis.

Several weeks ago the *Pioneer Press* published an article describing the organization and various improvements of the St. Paul Telephone Company, showing everything of interest, so far as the service in St. Paul is concerned. At that time data could not be secured regarding outside connections with St. Paul and Minneapolis. This feature of the service is fully covered by the facts herewith presented.

CONNECTIONS SECURED.

During the past season, exchanges have been established at St. Cloud, Mankato, and Northfield, and connections secured with sixteen of the most important cities in Minnesota. Trunk lines have been constructed from St. Paul to Mankato, a distance of one hundred and twenty-two miles, giving immediate connection with Farmington, Northfield, Faribault, St. Peter, Kasota, and Mankato. At each of these places, good exchanges are in operation, where, a year ago, the telephone was not thought of. The business men generally, of these cities, have taken advantage of the opportunity to place themselves in communication with St. Paul and Minneapolis. A line has also been constructed from Minneapolis to St. Cloud, a distance of seventy-four miles, connecting with Anoka, Elk River, Clear Lake, and all other points of consequence. Communication will be opened Monday, December 31, with Winona and Red Wing. This line was completed in July, but could not be placed in operation sooner, from the fact that twenty-two miles of the line was purchased from the Western Union Telegraph Company, and they have but recently vacated it. This gives St. Paul communication with Hastings, Red Wing, Wabasha, Lake City, Reed's Landing, and Winona, a distance of one hundred and seventeen miles.

A. J. Pattison, late manager of the Western Union Telegraph office in Ogden, Utah, was agreeably surprised, on the 27th ultimo, when a messenger brought to his residence a package which, in opening, proved to be a silver table-set, consisting of seven pieces, all of solid metal, splendidly wrought. Every piece is engraved, "Mr. and Mrs. A. J. Pattison, from Employees of the W U. Tel. Office, Christmas, 1883." The tray alone measures twenty by twenty-seven inches, other pieces in proportion. This handsome, useful, and costly gift was a present made to Mr. and Mrs. Pattison by the "boys" in the office, who keep their late manager in grateful and kind remembrance and undiminished esteem.

It is claimed that Italy makes more use of the telephone in proportion to population than any other country in the world. The General Italian Telephone Company increased its list of subscribers during the past year at least 100 per cent.

A Dog at the Telephone.

The telephone has enabled a physician, several miles away, to detect whether a child had the croup. The child's mouth was held near to the mouth-piece of the instrument, and the physician heard its cough. But more singular than this is the following case of a dog recognizing its master's voice through the telephone:

Jack is a coach dog that found his master by telephone. In some way Jack got lost, and fortunately was found by one of his master's friends, who went to his office and asked by telephone if the man had lost his dog.

"Yes; where is he?" was the reply.

"He is here. Suppose you call him through the telephone." The dog's ear was placed over the ear-piece, and his master said, "Jack! Jack! how are you, Jack?"

Jack instantly recognized the voice, and began to yell. He licked the telephone fondly, seeming to think that his master was inside the machine.

At the other end of the line the gentleman recognized the familiar barks, and shortly afterward he reached his friend's office to claim his property.

The New Telephone Girl.

There is a new girl in the telephone office, and she is a very flip young woman.

"Hello, Central!" called a subscriber the other morning.

"Hello?" came the answer.

"Give me the National New Haven Bank," he said.

"What?"

"Give me the National New Haven Bank," he said.

"Get out! Do you want the earth? How can I give you a bank? I ain't got ten cents to my name." And she knocked the connecting link clear across the office, and began humming "Over the Garden Wall."

Trouble in Terre Haute, Ind.

A committee, representing the telephone subscribers of Terre Haute, Ind., called upon the officials of the company operating that exchange, and asked that the telephone rates be reduced.

The officers of the company, after taking the matter into consideration, replied that they did not think they would be justified in making any reduction. The committee returned to Terre Haute with their report—that no reduction could be allowed—whereupon it was decided to take out all telephones January 1, 1884. The committee reported that the telephone company will remove their exchange from Terre Haute rather than submit to the reduction asked, which was three dollars for business houses and two dollars for residences.

It is stated that the Societe Generale des Telephones of France, now has 5,400 subscribers against 3,955 in last December. Of this number, 4,794 are actually connected up, whilst of the 3,955 subscribers last year there were only 3,524 in connecion.

Mr. H. C. Haskins, general manager of the Wisconsin Telephone Company is at Jacksonville, Florida, for his health.

Mr. A. Hibbard, the energetic superintendent of the same company, is also under the weather—overwork in both cases. Look out for your health, boys, as well as for the shekels.

The telephone system of London includes seventeen stations and 3,310 subscribers. There are only 42,500 telephones in use in the United Kingdom.

At a meeting of the executive committee of the Central Union Telephone Company, held in Chicago December 28, 1883, a quarterly dividend of one and one-half (1½) per cent., payable January 15, 1884, on the capital stock outstanding was declared.

The stockholders are informed that the business of the company continues to show a very satisfactory increase from month to month.

TELEGRAPHIC

The Bennett-Mackey Cables.

There seems to be general satisfaction felt by business men all over the country with the plan to give them independent cable connection with Europe. For a long time the business community has been, to a certain extent, in the power of that gigantic monopoly which, if it has not assumed a censorship over cablegrams, has at least dictated where and through what medium they shall be received.

It is safe to prophesy that the cable ring, even should it drain its money pots to the lees, have yet sufficient gold to buy out a company controlled by such men as Messrs. Bennett and Mackey, and so the business public need not entertain the fears and suspicions usually awakened when, with a great blare of trumpets, a body of capitalists, announce that they are about to establish a people's telegraph.

No wonder a shout of satisfaction goes up all over the country when two reputable men, with careers of honor at stake, organize an independent cable company.

The organizers of the new company promise that the rates shall be greatly reduced from the present ruling figures, and that the efficiency of the service shall not be lessened by reason of such reduction.

The present cable monopolists claim that they charge only fifty cents a word. Yet every man who sends a cablegram knows how false this statement is, just as every business man knows that it is made with a purpose to deceive.

Surely, if a telegraph company advertised to send ten words a certain distance for twenty-five cents, and then charged you twenty-five cents extra for the address, you would look upon its public announcement as a willful attempt to deceive, for you could not send your message without addressing it to some one and signing it.

Yet this is just what the cable monopolists are doing to-day. Only the other day we heard of a case where a man who sent a cablegram of nine words was charged seventeen dollars, the larger amount being for the address.

Notwithstanding this system of extortion, the company, with unparalleled effrontery, announces that it only charges fifty cents the word.

Give us the new cables at the earliest possible moment!

Tearing Down Telegraph Poles.

YOUNGSTOWN, O.—Employes of the New York, Pennsylvania and Ohio Railroad on Saturday last began tearing down telegraph poles recently erected along the line of the new Pittsburgh, Cleveland and Toledo Railroad. Officials of the first-named road claim the poles on their land, and say they will remove them along the entire line. No attempt was made to stop them. President Andrews and Superintendent Agnew, of the new road, are away, and no instructions have been received from them. The trouble arises from the disputed ownership of an old canal bed, and is the same which led to the riots two weeks ago.

Arrangements, which have been slowly maturing for many months, are rapidly approaching completion for introducing the American, British and Continental Cable Company, and it is expected that at an early date in January the scheme will be placed before the public, with a directorate embracing names of the highest commercial standing.

The company intends to begin operations with a maximum rate of one shilling per word as soon as the first cable is laid, with an assurance to its patrons of a still greater reduction in rates when the second cable is completed. It is believed that this reduced rate will be made commercially profitable by the improved telegraphic apparatus in possession of the company, which, it is said, will enable 50 words per minute to be transmitted. The only relief from the exorbitant tariff charged by the companies comprising the cable ring is to be looked for in a wholly independent enterprise like this. For this reason, if for no other, the new company merits, and will doubtless receive the support of the public.—*Money, December* 12, 1883.

Presented to Superintendent Hern.

The employes of the Mutual Union Telegraph Co., of Boston, on the 3rd inst. presented to D. J. Hern, the superintendent of the office, an elegant photograph album, together with a handsome ebony table, covered with embroidered silk plush. He was also the recipient of a life-size crayon portrait of himself, the work of Mrs. D. C. McDonald, formerly manager of the Mutual Union office in Belfast, Me. Mr. Hern made fitting acknowledgment of the several tokens of esteem.

The largest cable yet laid across the Mississippi River is the one just placed in position by the Postal Telegraph Company, which promises to begin sending messages from St. Louis to the East by the end of this month. The cable was 3,400 feet long, weighed 16,000 pounds, and measured eight inches in diameter.

D. H. Bates resigned his place as Assistant General Manager of the Western Union Telegraph Company yesterday, to take the place of President and General Manager of the Baltimore and Ohio Telegraph Company, made vacant by the retirement of George P. Frick. Western Union officers said that Mr. Bates's retirement was sudden and unlooked for. Mr. Bates is one of the oldest telegraph men in the country, and was prominently identified with Gen. Thomas T. Eckert and Jay Gould in the Atlantic and Pacific and American Union Companies as well as the Western Union.

Mr. Mackey Elected President.

The newly-elected directors of the Postal Telegraph and Cable Company are John W. Mackey, Virginia City, Nev.; Henry Cummins, H. L. Horton, Henry Rosener, George S. Coe, William K. Soutter, George S Hart, and David B. Davidson, of New York City; George W. Cass, Pittsburgh, Penn.; Alanson W. Beard, Boston; Ferdinand W. Peck and E. L. Gillette, Chicago; and Hector de Castro, Paris, France. At their meeting on Monday last, the organization of the new company was perfected by the election of John W. Mackey, President; George S. Coe, Vice-President; Henry Cummins, Second Vice-President and General Manager; H. L. Horton, Treasurer; George W. Williamson, Secretary, and William H. Fairbank, Superintendent of Construction. The company has completed its pole lines to Washington by way of Philadelphia and Baltimore, from Chicago to St. Louis, from Buffalo to Pittsburgh, through the oil regions, and from Fostoria to Toledo. Wires on these lines are now being strung, and they will be opened for business about the middle of next February.

At a meeting of the board of directors of the Cumberland Telephone and Telegraph Company, held December 22, a quarterly dividend of 1¼ per cent. was declared.

The Great Southern Telephone and Telegraph Company has given notice that its regular quarterly dividend for this quarter will be 1½ per cent.

A Review of the Work Done in Colorado during the Past Year.

During the past year there has been no unusual activity in the telegraphic world in Colorado, although everything connected therewith has been moving along smoothly, and material improvements in the system have been made.

Denver is the nucleus of the telegraph system in Colorado, the principal office of the Western Union Company being located here with Mr. B. R. Bates in charge. This gentleman has, during his term of office as Assistant General Superintendent, had many discouraging events to contend with, but has shown himself equal to the occasion by pulling through and placing the service where it now is, in better shape than ever before. One of the events referred to was the strike of the operators of the Denver office a year ago last August.

All the operators with one exception left their keys, and for several weeks the office was shorthanded. The men who struck are now scattered over the United States in different localities. Several have quit the business, and two of them are again at work in the Denver office.

During the general strike of telegraph operators last July the men in the Denver office remained faithful to the company, and refused to quit their desks. Although it is admitted that the office here has never been manned with as proficient operators since the strike of a year ago, still it cannot be said that the force now on duty is below the average, as some of the operators rank with the first-class men of the country. The present force is as follows:

B. R. Bates, Manager and Assistant Superintendent

E. R. Harding, Private Secretary to Manager.

T. B. Wells, Assistant Manager.

F. M. Crittenton, Day Chief Operator.

George E. Lawton, Night Chief Operator.

John M. Hogan, Eugene Street, Frank Reynolds, W. N. Fashbaugh, J. A. Hard, T. Babb, Mrs. S. C. Hilker, J. I. Briggs, Frank Gargan, D. Spencer, John Jenkins and W. J. Parrott, operators.

During the year 1883 there have been fifteen new offices opened in Colorado. Most of these were railroad offices which handle commercial business. The number of miles of new lines strung during the year was comparatively insignificant.

The following list of the number of messages handled in the Denver office during the year will doubtless prove of interest:

Messages sent away from Denver	152 000
Messages received in Denver	140,000
Messages relayed	167,900
Number words Press sent	3,502,000
Number words Press received	2,485,000
Number words Press relayed	142,803

The American District Messenger System.

In connection with, and closely allied to the telegraph system, is the messenger system. Denver can boast of as thorough an equipment in this department as any other city in the Union. There are altogether in the city about 1,050 call boxes and thirty messenger boys.

Mr. F. R. Arbuckle has charge of the system as superintendent.

Spreading its Lines of Wires.

The Merchants and Bankers' Telegraph Company, of this City, have at last succeeded in obtaining possession of the Lehigh Telegraph Company, to gain a majority of whose stock the former company has been striving for some time. The new property is valuable, and with it the Merchants and Bankers' Co. will have another formidable link in their fast increasing chain of wire in opposition to the Western Union.

It began in 1876 as a local company with a short line in Lehigh County, but it constantly increased its line, and, a new charter being obtained in 1878, its business was largely accelerated. The line now runs to the principal points in Lehigh and Schuylkill Counties, its principle offices being in Reading, Norristown, Quakertown, Pottstown, and Slatington. The work of completing the line to Philadelphia will be pushed, and the offices in that city will soon be ready for business. This absorption gives the company 500 miles of additional wire.

BOSTON, Mass.

Editor Electrical Review:

SIR,—I observe on the fifth page of your issue of December 20th, a report of an interview with a "prominent electrician," who, according to said report, certifies generally to the total harmlessness of the electric lighting currents.

Now, while I fully agree with the said "prominent electrician" as to the correctness of his assertion, I should like to point out respectfully to him that his statements are weakened before the general public, as represented by your readers, by reason of the following facts:

The name of the "prominent electrician" is not given. No statement regarding such electrical appliances as the dynamo-electric machine, or its current, when generated for lighting purposes, can be regarded as being authoritative, or even worthy of consideration, unless the promulgator has sufficient confidence in it to permit his name to be used; or in the case of an electrical paper, unless given as an editorial or leading article, it being always assumed that under the latter circumstances the editor will make no statement unless it is at least approximately correct, and well established.

Moreover, the gentleman is proved to be an interested party by his expression, "Our men," and the repeated use of the pronoun "we." This of itself would carry no weight, but coupled with the absence of his name, it weakens his statement.

Lastly, he says, "*I claim that they cannot get hurt unless a wire is cut, etc.*" The objectionable part in this, is the phrase, "*I claim.*" What weight does a claim carry in a controversy?

It is not long since a gentleman on the other side of the controversy *claimed* a result exactly opposite to the claim of our friend, but that claim has been closely criticised, in fact weighed in the balances and found wanting; which circumstance shows what a *claim* is worth.

"I claim," or "he claims" is newspaper English, and should be eliminated from the vocabulary of electricians. I submit to you, Mr. Editor, that unless an electrician has the necessary faith in his own statements and ideas, to say "such a thing is, or is not the case," and if necessary to endorse his views by his own name, or by his well-known *nom de plume*, if an habitual writer, he had better refrain from saying anything, as there is nothing more easy than to meet a claim by a counterclaim.

The foolish story that firemen are likely to be hurt by the infringement of a stream of water against an electric light wire should need no disproval. Unfortunately, however, such stories are much easier to set afloat than to root up. I fully exposed the ridiculous folly of the idea in your paper of December 15th, 1882; I can add at least three persons to the list of fatal casualties mentioned by the gentleman interviewed, but what of it? In every case the lamentable result accrued from heedlessness or recklessness of the persons themselves, who in all but the first case knew better, while the victim in the first case was told of the risk he ran.

To be consistent, if every appliance of civilized life, which has an element of danger must be cast away, what shall we do with the gas-light, which numbers its *hundred* victims to every *one* of the electric illuminant; and what shall we say of that well-known depopulator, "kerosene oil," for truly, if electricity had slain its units, and gas its hundreds, kerosene hath already slain its tens of thousands.

THOMAS D. LOCKWOOD.

Electrical Review,

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We extend to manufacturers of electrical apparatus an invitation to send to this office any and all facts concerning their business which will be of interest to the public. We make no charge for publishing news.

Those desiring to recommend their goods can do so to any extent in our advertising columns, but we will not publish for pay anything of the nature in our reading columns.

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Government Control of the Telegraph.

The interest taken by the public at large in this question has resulted, as might have been expected, in the drawing up of a bill in which it is recommended for the consideration of Congress. This bill will, with little doubt, be presented during the present session, and is likely to cause unusual controversy between its supporters who seem to be numerous, and its opponents who, unless we are greatly mistaken in them, will make a stubborn resistance to its passage.

We have, upon several occasions discussed in the columns of the REVIEW the claims set up by those who favor Government control of the telegraph, and have enumerated the many evils which, under a republican form of government, are likely to follow a surrender to the State of any considerable power which rightly belongs to the common people.

We have not seen any reason to change our opinions upon this important question. At the same time the policy of the REVIEW is to treat every subject impartially, and hence it is that we now lay before our readers some of the arguments which are brought forward by the friends of the scheme for a Government control of the telegraph, so that even the most casual reader may have the opportunity to consider the evidence both for and against it, and thus be left untrammeled to form his own opinion.

In a paper contributed to the *North American Review* on "Government Control of the Telegraph," Mr. Gardner Hubbard urges the State to go into the telegraph business without purchasing existing lines; in other words, to establish a "postal telegraph."

He says: "Congress could create a postal system, using the present post-offices and delivery system, either constructing its own lines or contracting with parties to furnish all necessary lines for transmitting telegrams the contractors receiving the rates fixed by Congress in full compensation for constructing, maintaining and operating the lines the post-office furnishing such additional facilities as might be required for the purpose of transmitting, at low rates and with greater economy, business of a less urgent nature than that now sent over the Western Union lines. The Western Union would continue to perform a large part of the commercial business, on account of greater dispatch, and the business of the railroads. It would be inexpedient to adopt a low and uniform rate at once, as it would increase the business beyond the ability of the postal department or of any company to handle it. I believe that a uniform rate of thirty cents between all offices, and a day rate of twenty-five cents between offices east of the Mississippi, and offices west of that river and east of the Rocky Mountains, and a rate not exceeding fifty cents between any two offices in different sections, would give the people what they need, and make the postal telegraph self-supporting. There are now at least 50,000,000 messages transmitted yearly by existing companies, requiring not less than 150,000 miles of pole lines. In six years at the ordinary rate of increase, 100,000,000 messages will be transmitted. If a postal system with low rates should be inaugurated, the number would be increased to 150,000,000 messages, which would give business enough for all the lines and employes of the Western Union and the postal system."

Congress should also enact laws regulating the present service, prohibiting stock dividends, and also prohibiting the increase of capital, except for cash, and to the par value of the stock issued; prohibiting consolidations, either by lease or purchase, unless made with the approval of the Postmaster-General, and then at a valuation made by appraisers nominated by the Supreme Judicial Court of the United States. Congress should also give to the press the right to use the telegraph without discrimination in price. It should limit the business of a telegraph company to the transmission of messages, and provide that any telegraph company connecting with another shall have its messages carried over the lines of the other company at pro rata rates, and without undue delay. It should provide for full annual returns of the business of the several companies to the Postmaster-General, and limit the dividends to seven per cent. a year on their capital."

It cannot be said that Mr. Hubbard makes out a very strong case. Should such a scheme be adopted, the whole power of the State would be used to crush out a private enterprise without even offering to its promoters and proprietors a fair sum for their property. Such a proceeding, besides constituting a grave injustice, would be so contrary to the very first principles of republican government, in which the rights of the people are paramount, that it is hard to conceive of an intelligent man entertaining them.

If Mr. Hubbard were not a millionaire, but instead a poor man struggling to extend a small business, or had he only the average income possessed by business men, which income was derived from a legitimate enterprise, inaugurated or at least developed in part by himself he would undoubtedly be found among the first to protest against the State itself going into the same business with the National treasury at its back.

Would not the spirit of the Constitution be against a project looking to a participation on the part of the State in the grocery business of the country? What would become of the average grocer should the State begin the grocery business on a grand scale? He would assuredly be unable to make a living. Surely, if the State went into the telegraph business, it might go into every other kind of business.

Every one who comprehends the spirit of the Constitution will agree that it absolutely forbids any competition by the State with private enterprise. Otherwise the State would soon be stronger than the people whence it receives its power.

Those who have examined the workings of a department under political management, and all the National departments may be looked upon as controlled by politicians, will be slow to believe that, on a business basis such a department can be operated either as efficiently or as economically as a similar one managed by private corporations or by business men.

If then, it may be asked, a governmental department could not work so efficiently nor so economically, why should there be any fear of the Government as a competitor? The answer to this question will be at once apparent to every intelligent reader. It is because the Government, having unlimited capital, can afford to do an unprofitable business, which would be out of the question with corporations or private individuals.

Mr. Hubbard might have made a good point had he dwelt upon the abuse of power by private corporations, such, for instance, as the Western Union Telegraph Company. He might have shown that such corporations care nothing for either the public's rights or its interests; that, as in the case of the Western Union, they never see the opportunity opened to them of profiting by the necessities of the public without taking advantage of it. They will exact their pound of flesh, even when the exaction does not bring in so much as is promised by a more lenient policy.

What the people demand is not that the State shall go into business, but that it shall curtail the power of corporations; but that it shall force them in return for the valuable franchises which they receive at the hands of the people, to give in return an equivalent in fair and equable treatment.

Such restrictions put upon the Western Union Telegraph Company would force it to change its present policy. It would force it to relinquish the system of extorting from the public a high interest upon stock which only cost the printing. It would force it to make reasonable rates to other points save those occupied by rival companies. Lastly, it would prevent a giant corporation like the Western Union from buying up or killing rival companies to the great injury of the public interests.

This is the kind of legislation the public demands, and what it may justly receive.

Electricity in Peace and War.

It is a peculiarity of the popular form of government that only that is considered which emergency makes urgent. The Congress busies itself with such matters as have been thrust upon its attention and which have a direct bearing upon a present condition.

Thus, there being no immediate prospect of war, the army and navy have been suffered to lapse into a condition of inefficiency. Not even the pleadings of able officers for appropriations to enable them to continue the most important experiments in gunnery and torpedo practice, are heeded by the representatives of the people, for the reason that, as a state of war does not exist, there is, in their opinion, no necessity for war-like experiments.

That this is a short-sighted policy there is abundant proof at hand to demonstrate. It is especially so at this time because the great improvements recently made in the science of war renders efficiency in the practice more a question of experience than of skill. It is certain, for example, that electricity is to play a very important part in future wars, and there is little doubt that it will find as broad a field in the operations of future armaments as it has of late years found in commerce and manufacture.

Believing this, Lieut. Col. Abbot, of the engineer corps, has for some time been experimenting with electricity at Willett's Point, in the East River, but now he is compelled, in great measure, to discontinue them owing to the refusal of Congress to make the necessary appropriations.

There is, we understand, a prospect afoot to urge upon Congress to take a different view of this matter, and the REVIEW will do all in its power to assist so worthy an endeavor.

It must be remembered that it was in this country that the utilization of electricity as an exploding agent for war purposes received its first great impetus, and important improvements in exploding instruments, electric prizes and other appliances have been made from time to time by Smith, Farmer, Hill, Striedenger and others. But it is safe to say that no man in this country has done so much toward perfecting a service of submarine explosion as General Abbot, of the Engineers. For years he has been engaged upon valuable work connected with the application of electricity to explosions, and in seeking out the exact conditions necessary to insure simultaneous submarine explosions on a grand scale. We had the pleasure of being present, sometime ago, while General Abbot was making some experiments for the purpose of protecting torpedo buoys, and we must confess to have been struck with the exactness with which everything was calculated.

A buoy, anchored in the river, marked the position of a submarine torpedo. An old canal boat was permitted to drift down on this buoy, and, as it touched the end of the spar, it drew the fire of a gun mounted on an earthwork on the shore, and was immediately riddled with grape shot. In other words, there was an electrical connection between the spar-buoy and the gun, the latter working automatically so that, even in the darkest night, an instantaneous discharge of the gun would have followed a molestation of the buoy which served to mark the position of the torpedo. The latter was also connected with the shore electrically and could be brought to the surface and exploded whenever it was desired to destroy any vessel that should cross its track. The buoy, if displaced, could be re-set, even in the dark, by means of sextant angles taken from known points ashore, these latter being distinguished by colored lights.

This is not meant to be described here as a remarkable piece of engineering skill, but simply as a sample of the ingenuity shown by General Abbot and his assistants, of devising various expedients of obtaining a desired end; one arrangement failing and another at hand.

In an official report upon investigations to develop a system of submarine mines for

defending the harbors of the United States, which was printed in 1881, General Abbot gives an account of a most valuable series of experimental and theoretical investigations of the physical phenomena and force developed by sub-marine explosions with all the most prominent explosive mixtures and compounds, and of the properties and relative merits of the various high, medium, and low tension fuzes, and of every class of electrical igniting apparatus.

Just what can and cannot be done in actual warfare by means of electricity, it is impossible to say, for electrical submarine operations have not yet been carried on upon a large scale; but we have already had abundant proof of the moral effect of submarine mines.

"In the war which was carried on for six years by the Republics of Brazil and of Uruguay and the Argentine Republic of Paraguay," says Sir Frederick Abel, "the latter managed, by means of submarine mines, to keep at bay for the whole period the Brazilian fleet of fifteen ironclads and sixty other men-of-war. The means available for applying electricity to the explosion of these mines were limited; a large proportion of the three hundred that were laid down were therefore arranged for explosion by mechanical means. In the Russo-Turkish war, submarine mines and torpedoes were a source of continued apprehension, and it is well known that the French naval superiority was paralysed, during the Franco-German war, by the existence, or reputed existence, of mines in the Danube.

"The application of electricity to the explosion of military mines, and to the demolition of works and buildings, from a safe distance, has, it need hardly be stated, been of great importance in recent wars in expediting and facilitating the work of the military engineer. The rapidity with which guns, carriages, &c., were disabled and destroyed by a small party of men who landed after the silencing of the forts at Alexandria furnished an excellent illustration of the advantages of electrical exploding arrangements, combined with the great facility afforded for rapid operation by the power possessed of developing the most violent action of gun-cotton, dynamite, &c., through the agency of a detonation without any necessity for confining or tamping the charge.

"The application of electricity to the explosion of mines for land defences during active war is by no means an easy operation, inasmuch as not only the preparation of the mines, but also the concealment of electric cables and all appliances from the enemy, entails great difficulties, unless circumstances have permitted, or have appeared to render it prudent to make the necessary arrangements in ample time to prevent a knowledge of them reaching the enemy. An elaborate system had been elaborated for defending the chief approaches to Paris in this way in 1870, but no preparations were attempted until it was impracticable to render this system of defence available."

Leaving warlike operations and turning to more peaceful fields, we find that electricity is gradually revolutionizing the old methods. Electrical blasting when applied to rock-boring machines, has made the operations for tunnelling and excavation of galleries comparatively easy, and, although in ordinary mining and quarrying operations, the additional cost involved in the employment of fuzes and conductors, and the original price of the exploding machine are not unfrequently of serious consideration there are, says an authority, even in those directions, many occasions when the power of firing a number of shots simultaneously is of very great importance.

The safety of electrical blasting is likely to make it more popular year by year; the record showing that both in mining and quarrying it is nearly ninety per cent. safer than by the slow fuze.

The operations of General Newton, United States Engineers in and about Hell Gate, East River are the most extensive applications of electricity for the removal of natural obstructions to navigation, yet recorded. The area of rock operated upon, which included all that portion of the reef within the curve of 26 feet below mean low-water, was, so says an authority, 3 acres. This space was perforated with forty-one radial tunnels, long and short, and with eleven transverse galleries, leaving as supports to the roof one hundred and seventy-two piers. The aggregate length of tunnels and galleries was 742,567 feet; the amount of rock which had been excavated from these was 49,480 cubic yards; and the time consumed in this work was four years and four months. The work of drilling charge-holes was commenced in June, 1875, and at its completion, in March, 1876, five thousand three hundred and seventy-five 3-inch holes had been drilled in the roofs, and in the piers one-thousand and eighty 3-inch, and two hundred and eighty-six 2-inch holes; the total length of holes drilled being 58,445 feet. In the earlier portion of the work of excavation powder was used for blasting, but from June, 1872, machine drills and violent explosives were gradually brought into use. Dittmarr's preparation of nitrated sawdust and nitro-glycerine, known as dualin, and nitro-glycerine alone, manufactured by Mr. Mowbray, were employed experimentally in the earlier operations. In the concluding demolition the explosives used were giant powder, or No. 1 dynamite; rendrock and Vulcan powder, or Vigorite, another nitro-glycerine preparation, which is a mixture of nitrate of soda, sulphur, and charcoal, with about 30 per cent. of nitro-glycerine. A total of 49,914 lb. of these explosives was used in the single operation. The number of holes charged with these was four thousand four hundred and twenty-seven. The operation of charging occupied nine days. The detonating electric fuzes, charged with mercury fulminate, were contained in priming charges weighing ¾ lb. each, enclosed in brass tubes; these were inserted over the charges, which were enclosed in tin cases hermetically closed to exclude access of water. Very simple and effectual means were used for fixing the cases in the holes in the roofs of the galleries, &c. The charges were connected in continuous series in groups of twenty, and these again were arranged in divided circuit in eight groups, every group being connected with a distinct carbon zinc battery of forty to forty-four cells. Each battery was thus arranged to explode one hundred and sixty charges. The simultaneous explosion of the complete system of mines was accomplished by a simple circuit-closer, governing the whole of the twenty-three series of charges, which was devised by Julius Striedinger, C. E., who rendered important services in connection with the electrical arrangements.

All was completed by the 23rd of September, 1876. Water was admitted to the excavations, which were filled to the level of the tide in seven and a half hours, and the simultaneous explosion of the charges was effected on the following day. The maximum height to which spray was projected by the explosion was 123 feet, the volume of water raised being comparatively trifling, as was also the shock of the explosion. Advantage was taken of this stupendous operation to make observations on the rate of transmission through the earth's crust of an artificially produced impulse analogous to an earthquake; and this work was entrusted to General Abbot, who worked out the formulæ regulating the arrangements of the batteries, fuzes, and circuits by which the operations were brought to a successful issue. The total amount of rock demolished by the explosion was 63,135 cubic yards.

The reason for the blasting of the Hell Gate rocks was in order to clear out the approaches to New York City *via* Long Island Sound; a passage, which, if the additional operations now under way, shall also prove successful, will, in all likelihood, prove, in the future more favorable for the passage of big ships, than the tortuous and shoal channels *via* Sandy Hook.

It is safe to say that, without the aid of electricity, such gigantic operations as those described would be impracticable, if not impossible.

For the Electrical Review.

The Underground Question.

Plans for laying electric wires beneath the earth's surface have been made without number. This method of disposing of the telegraphic conductors seems indeed to have been thought of by the earliest inventors of practical telegraphs, even to the exclusion of aerial wires; and Morse in the United States, as well as Cooke & Wheatstone in England, laid, or attempted to lay, their first lines underground.

Insulation was, in those dark days of electrical science, an unknown art, and thus these early attempts became failures.

Submarine cables have, from 1852 to the present time, been continually laid, with an ever increasing degree of success, and this is in a great measure due to the suitability of gutta-percha as an insulating covering for the wires.

Gutta-percha and India-rubber have also been extensively used for wires to be laid underground, for it must not be thought that the attempts we have already noticed were the only attempts made to lay wires underground.

The English telegraph companies, and of late years the English Government, have made many attempts, with more or less success, to establish systems of subterranean conductors. Until lately, long lines so laid have not shown a glittering degree of success, at least not for a lengthened period; but the short city lines of London and other large cities and towns have for many years now been very fairly operated, and have exhibited a very fair average of durability. The system adopted has been to establish at suitable distances from one another test boxes, and to connect these boxes by iron tubes, through which the insulated wires are drawn; the said wires being insulated with gutta-percha, and then wound with tarred tape.

It must be remembered that these wires are not, strictly speaking, local conductors, such as our quotation, district, and telephone lines, but are regular telegraph lines, connecting one telegraph office with another, and also forming the city extensions of trunk telegraph lines.

We are well aware (for we have heard it so often that we can have no excuse for ignorance), that in Germany the Imperial Government has established a system of underground cables, extending between some of the principal cities of the Empire. These lines were laid as a military precaution, and are worked, although communication over them is effected but slowly.

During the last few years the French Department of Telegraphs has constructed some subterranean telegraph lines which are said to work satisfactorily. These also were laid as a matter of military expediency, it being clear to any one who watches the political horizon, that with any of the Continental powers of Europe the only judicial course to pursue is in time of peace to prepare for war.

The above facts are constantly brought forward by the advocates of an indiscriminate burial of wires; and to the mind which has little or no acquaintance with electrical phenomena, the argument is almost irresistible.

It is argued that if the effete monarchies of Europe can do such things, why not the inventive American? And why not indeed? The said inventive American, then, and especially that portion of him who knows nothing about the subject, forthwith sets his powerful and inventive mind to inventing (utterly mistaking, let it here be said, the nature of the invention required), and produces *a conduit wherein to carry wires.*

Perhaps there have been as many English and American patents granted for arrangements for placing wires underground, as in any branch of electrical invention, and nearly all relate to the mechanical details of laying and supporting the wires, and between the most of them is a general family likeness. Still, the germs of subterranean wires may be divided into several species. There are, for example, the box or curb conduit, in which insulated wires are supported by partitions placed at suitable distances from one another; the conduit in which bare wires are supported by bridge suppports of some non-conducting material; the tube, conveying insulated wires bunched together, and provided with test-boxes or working-vaults, into which the pipes enter; the cable buried directly in the ground, and so on.

Each inventor, as a general thing, stoutly holds that he, and he only, has the true and complete solution of the underground problem, and holds in unmitigated scorn the productions of other inventors. It is a curious fact, also, that the greater part of these inventors are *not* electricians, and therefore do not and cannot comprehend the real difficulties in the way. It is, unfortunately, too true that the patented improvements—most of them, at least—are only such methods or schemes which would readily occur to any mind when thinking upon the subject, either to be rejected as being impracticable or to be used as a matter of course. In addition to the initial expense of construction (which, of course, is at least four times greater than that aerial work, but which would prove no bar in the way, as being balanced by the greater immunity from elemental troubles), the difficulties which present themselves are, I apprehend, chiefly the following: The greater loss which would ensue, should lightning strike the wires, this owing to the nearer contiguity of the several wires, and to the necessity of having the wires insulated throughout their length; also the deleterious effects of electro-static and dynamic induction, exhibited, in the first instance, by retardation and prolongation of signals, and, in the second, by the intermixture of the signals of one wire with those of others. Both of these types of induction occur in aerial lines likewise, but are much less pronounced, inasmuch as the dynamic induction between wire and wire depends, all things being equal, upon the distance between the wires, and this, of course, is much greater in overhead lines; while the static induction depends, under the same conditions, chiefly upon the distance between the wires and the earth; this, of course, being in still a higher degree greater in aerial lines.

But, it will be objected, these phenomena enter as much into the European lines, do they not? Certainly they do. We may as well state that the dynamic induction, though a formidable enemy to telephone lines, would not of itself form much of an obstacle to underground telegraphy. It is the static induction which is most radically detrimental. Very few of the European lines are as long, or anywhere near as long, as many of our lines, and yet it is stated by Mr. Preece and others that the static induction affects their lines so strongly as to materially lessen the rate of transmission, and particularly in fast systems of telegraphy. The trouble of retardation, due to static induction, varies in submerged or buried cables, according to Sir William Thomson, with the square of the distance, so that a very little longer line is retarded very much more; and this, therefore, constitutes the worst enemy to underground telegraphy. It thus appears that if we are content to pay the necessary price, and to dispense with speed (for retardation means the reduction of speed of transmission to about one-fourth), and can provide a perfect lightning protector, we may be able to lay telegraph wires, in cities at least, beneath the surface of the earth. We should, however, also take into consideration the additional annoyance to citizens in the necessary street excavation.

The condition of dispensing with speed has an alternative, which, however, seems to be at present still undiscovered, namely, some radical remedy for the effects of static induction. It is true that many partial remedies have been discovered or invented, but they are by no means perfect, the principal being based upon compensation.

Dr. Werner Siemens, many years ago, invented the parallel metallic circuit as a cure for inductional troubles, stating its applicability as a remedy alike for the effects of static and dynamic induction.

But this remedy is by no means susceptible

of universal application, since the majority of telegraphic circuits are operated with an earth return.

It might fairly be presumed, even without actual trial, that the electrical phenomena, which oppose the universal construction of subterranean telegraph lines, would, in an highly-emphasized degree, affect telephone lines adversely, and so it has proved. The telephone is an instrument exquisitely sensitive to electrical changes, and is, therefore, peculiarly susceptible to extraneous influences. Its legitimate currents are originated in a very small induction coil, energized by a single cell of battery, and are themselves, therefore, very feeble and weak. It must thus of necessity be sensitive, so as to respond to these weak currents, and its sensitiveness makes it a ready recipient of foreign currents, with respect to which it acts something like an electroscope. It is almost at this time superfluous to repeat the oft-told tale that the induction between telephone wires, when laid together underground, is very great, and that, unless suitable preventives are employed, any message passing upon any wire is repeated upon those contiguous thereto, and it is only referred to here as a reminder that in telephone work perfect insulation is not a guarantee against such interfering currents, and that, even should underground construction prove to be a brilliant success in telegraphy, that would be no argument of its perfect adaptability to telephone wires. We can, of course, adopt the remedies of metallic circuits, or metal screens connected with the earth, but the first plan means a complete duplication of every existing wire, and the second plan at once introduces our other and more serious enemy—static induction. Quite a number of inventors have asserted their systems of cables and conduit conductors to be free from this latter evil. I will, however, venture to say that, out of twenty lines laid underground, eighteen will permit a magneto bell to ring over them when open at the other end, showing the enormous increase in electro-static capacity. It is not surprising that, when we can ring a bell on an open wire, we find difficulty in conversing over it. This is to be expected, for the currents used are to-and-fro currents, and on even a short line the words run together, and tread on one another's heels as it were, while on a longer one the sound is much subduced, and in many cases obliterated altogether.

The reason of this is that the successive electrical pulsations being of alternate direction, and following one another very rapidly, when the first one is retarded by the inductive action of the earth, the next one follows it closely, and partly neutralizes it before it has time to reach the distant end, and so on, with each successive impulse. Likewise the pulsations, which do make themselves apparent at the distant end, are sluggish in their action on the receiving magnet, and being prolonged are reached by the next ones, thus producing, for all intents and purposes, one long signal, which for conversational purposes is undistinguishable.

I am aware that the plan of sending a reversed current immediately after the signaling current is used in automatic telegraphy, and in some cables to clear the line, and thus expedite the signals, but in such cases they do not even approximate to the speed of reversal obtained in telephony; they can, therefore, be controlled and utilized

We sometimes hear in the public prints that such and such a person, in the presence of certain eminent professors and electricians, has succeeded in talking with telephones over, say, thirty-six miles of subterranean wire. The sermon to that text is at once delivered, to the effect that it is now conclusively proved that this can be done, and that all further delay only proves the willful obstructionist policy of the telephone companies.

But upon investigation we generally find that, if this has been done at all (and it sometimes has not been), it has been effected by taking, let us say, a six-mile cable having six conductors, and connecting the conductors at the ends so as to have a continuous conductor throughout, which, if the cable is well insulated, is no test at all; for in many cases the induced currents are generated in the sixth line from the first, and we may actually open the cable at the junctions without interfering materially with the conversation.

At other times we find that this method of connecting is in reality a cure for retardation, because, if at any given moment the current in number one is plus, the charge it attracts to the outside of the insulating medium is of necessity minus; but in conductor number two, which, it will be remembered, is connected with number one at the distant end, the current is at the same moment minus, because it is the same current as in number one, but proceeding in an opposite direction. The charge attracted by number two is, therefore, plus, and the charge attracted by number one is thus neutralized by an opposing charge attracted by number two. This proceeding is repeated by the entire number of conductors, and we may thus see that such a test is by no means an equivalent of so many miles of actual underground line.

We are, upon reviewing the subjects, compelled to believe that only one plan can solve the underground problem, and that plan is the one which we have heretofore advocated, namely, the extensive subways under the streets. Till these are obtainable the wisest course for telephone men is to extend the aerial cable system, and avoid as much as possible poor construction and massing of wires. There is one consideration which has been entirely overlooked in the outcry against overhead wires, and that is the fact that the effect of retardation in a subterranean line is incomparably enhanced when that line is connected with a longer line. We have in Boston experienced this, when a short underground line of one-fourth of a mile has been connected with a three-mile line overhead; and the longer the aerial line is, or the longer the subterranean line is, the worse this feature appears. So far, then, as our experience goes, with the present appliances, a universal subterranean system of telephone wires in cities would completely extinguish the extra-territorial or out-of-town business.

The foregoing considerations are penned for the information of those who really want to know the reasons which deter telephone companies from yielding to the underground mania. They feel that they would rather endure the ills they have than fly to those they know not of. T. D. L.

Electric Gas Lighting.

The recent controversy over the rights to manufacture and sell Electric Gas Lighting Apparatus, has developed much interest on the part of dealers and consumers. It will therefore be interesting at this time to read the advertisement of Mr. A. L Bogart, on page 11, and to note the date of issue and subject-matter of the patents granted and assigned to him, covering the whole field of electric gas lighting. Those who may buy or use the devices of his manufacture need have no fear of infringement suits from any party or corporation, and can rely upon securing the best made apparatus in this country.

The Mexican Telephone Stock Suit.

In regard to the telephone stock suit mentioned in our edition of last week, we gather the following additional information which would seem to be correct, as it is taken from the *Daily Register*, the official Law Journal:

"In a paragraph in Thursday's *Register*, under the above heading, it was stated that Judge Truax, in a suit by the Mexican Telephone Company against Frederick M. Delano, John D. Haines and George N. Blanchard, had granted an injunction restraining the transfer of shares of stock of another company owned by plaintiff pending the action. It appears that upon the injunction motion all the defendants denied the alleged irregularity in the issue of the stock in question, or that it was issued for the use or benefit, as alleged, of Delano or Haines, or either of them. Delano and Haines both swore that they had never owned or had any interest in the stock, and Blanchard made affidavit that he sold it in good faith eight months before this suit was brought."

Baltimore and Ohio Telegraph.

BALTIMORE, Md.—At a meeting of the Boards of Directors and Stockholders of the Baltimore and Ohio Telegraph Company, David H. Bates was elected President and General Manager. Mr. Bates's high standing as one of the best known and most successful telegraph men in the country, and the fact of his resigning the Vice-Presidency and office of Assistant General Manager of the Western Union Telegraph Company to accept the positions to which he has just been elected has given Baltimore and Ohio telegraph interests a decided impetus. It is currently reported that the details of several most important extensions of the Baltimore and Ohio system have already been perfected—among them direct wires to Milwaukee, St. Paul, Minneapolis, and intervening points in the Northwest, also corresponding facilities throughout the Southwest, while Boston and New England will be covered by new wires from New York.

A New Device for Lighting Gas.

A new device for lighting gas by electricity, called the Portable Electric Gas Igniter, is on exhibition at the office of Hurlburt & Co., in the Aldrich Building, at Chambers and Church streets The contrivance, which is a simple one, consists of a patent chloride of silver battery, with other chemicals which are kept secret, contained in a brass rod which ends in a carbon point. A patent vibrator makes the connection between the battery and the point. When the vibrator is turned the electricity from the battery through a coil, is carried along the brass rod to the carbon, and the spark resulting lights the gas. The whole thing is of light weight. The brass rod can be made of any length. Each battery has a capacity of making 50,000 electric sparks, and when it is used up a new one can be put in the cylinder for $1.50. The patent is an English one, the right of which has been bought for this country by an electrical manufacturing company of Boston, which paid $200,000 for it. The agents in this city are Hurlburt & Co. It has already been introduced in the Windsor Hotel, Delmonico's, Sturtevant House, Lord & Taylor's dry goods house, the Union Square and Madison Square theaters, and other hotels and business houses. In theater dressing-rooms and on the stage it is stated by managers to be of especial value as a means of safety in lighting the gas, where matches are often carelessly used. There is no danger of the spark igniting anything but gas.

Electric Light Consolidation.

BOSTON.—The American Electric and Illuminating Company, of Boston, has purchased the entire business, machinery, tools, franchises, shops, and plant of the Thomson and Houston Electric Light Company of Canada, with headquarters at Montreal, and assumed control of the same to-day. The transfer also carries to the American Electric and Illuminating Company the ownership of patents for Canada of the Thomson-Houston system, as well as all inventions of Thomson and Houston for the next five years. The business will be conducted as a Canadian branch of the American company.

The Electric Motor.

It may certainly be said that for pumping, sawing, and for such like operations of a large country house, an electric motor, actuated by the dynamo which lit the house at night, would be cheaper and quite as effective as a steam engine. Sir William Armstrong, at his place near Newcastle, has utilized a waterfall in his grounds to light his house by night and to supply it with power by day. The waterfall is 1,500 yards from the house. It actuates a turbine, which it connects by a belt to a dynamo-electric converter, capable of transmitting about five horse-power into a current of electricity. The current is conveyed by a suitable conductor to the house, where it works forty Swan lamps In the daytime it works a saw-mill. Sir William Siemens, at his country seat, near Tunbridge Wells, uses a steam engine, the waste steam of which warms the hot-houses. During the night the primary machines actuate two powerful electric lights, which are employed in forcing the growth of various fruits and plants, which live, as it were, in perpetual sunlight—or its equivalent. During daylight one of the machines is used to work a chaff-cutter, and other machines at the farm, a quarter of a mile away; the other does the pumping of the establishment. At night, of course, they are employed for light.

Mid-Winter Excursion to the Tropics.

In pursuance of their regular winter plan, Messrs. Leve & Alden, 207 Broadway, New York, who are now widely patronized by the traveling public, announce their third annual mid-winter excursion to Cuba and Nassau, New Providence. The party will leave New York, January 26th, under the management of Dr. F. W. Hutchinson, a gentleman of extensive experience and information concerning the regions visited.

The southward voyage will be made direct to Havana, upon the fine Ward Line steamer Niagara. Two weeks will be devoted to Havana, Matanzas, and Cienfuegos, the voyage from thence being made in the Ward Line steamship Santiago, stopping a day at historic Santiago de Cuba, and proceeding thence to Nassau, arriving there upon February 17th, and leaving upon March 2d—giving in all nearly forty days of travel upon summer seas and among the beautiful scenes of tropical life. The rate which has been fixed for the trip, $250, includes all expenses for passports as well as carriage hire, first-class hotel accommodation, and in fact all the needful items of such a journey, under the most agreeable auspices.

Telephone Stock Quotations.

American Bell Telephone Company	187
Central New York Telephone and Telegraph Company	103
Empire State Telephone and Telegraph Company	205
Hudson River Telephone and Telegraph Company	105
New York and New Jersey Telephone Company	85
Mexican Telephone Company	3¾
New York and Pennsylvania Telephone Company	67
Southern Bell Telephone and Telegraph Company	130
Tropical Telephone Company	2½
Central Union Telephone Company	100
Iowa Union " "	91
Missouri and Kansas Telephone Co.	92
United Telephone Company (Kansas and Missouri)	89
Bell Telephone Company, of Missouri	165
Wisconsin Telephone Company	125
Cumberland Telephone Company	100
Great Southern Telephone Company	100
Michigan Telephone Company	105
Chicago Telephone Company	286
Erie Telephone Company	41
Union Telephone Company	100
Southern New England Telephone Company	178
New England Telephone Company	75

Average Market Quotations of Battery Supplies for the Week Ending January 10, 1884.

Zincs (crow foot)	50c. each
Copper	10c. each
Jars (according to size)	35 to 60c. each
Blue vitriol	6½c. lb.
Sal ammoniac	12½c. lb.

Send to our advertisers for price lists.

ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENT OF THE UNITED STATES WERE GRANTED IN THE WEEK ENDING JANUARY 1, 1884.

291,063 Electrical annunciator; Albert E. Letch, Dayton, Ohio, assignor of one-half to Charles A. Phillips, same place.

291,072 Press for moulding glass insulators; Edward J. Murphy, Boston, Mass., assignor to Lawrence B. Gray and Joseph Ham, both of same place.

291,095 Railway train signal apparatus; Chas Selden, St. Louis, Mo.

291,096 Static neutralizer for telegraphs; Chas. Selden, St. Louis, Mo.

291,097 Static neutralizer for telegraphs; Chas. Selden, St. Louis, Mo.

291,141 System of electrical distribution; Charles S. Bradley, New York, N. Y.

291,170 Case for electric conductors; Henry Edmunds, Jr., New York, N. Y., assignor to Thos. J. Montgomery, Boston, Mass.

291,171 Bracket for electric lamps; Henry Edmunds, Jr., New York, N. Y., assignor to Thos. J. Montgomery, Boston, Mass.

291,209 Exciting circuit for dynamo-electric machines; Charles Lever, Bowdon, County of Chester, England.

291,211 Telegraph wire joint; Charles McIntire, Newark, N. J.

291,236 Quadruplex telegraph; Gerritt Smith, Astoria, N. Y.

291,239 Apparatus for covering electric conductors; Henry D. Stanley, Bridgeport, Conn., assignor to the Bridgeport Brass Co., same place.

291,241 Electric battery; James L. Tobin, Newark, N. J.

291,286 Zinc for batteries; Horatio J. Brewer, New York, N. Y.

291,288 Electric fire arm; Alexander F. Brown, Syracuse, N. Y., assignor of one-half to Lyman C. Smith, Syracuse, N. Y.

291,299 Protector for telephonic and telegraphic instruments; Anthony A. Connolly, Washington, D. C.

291,310 Combined burglar alarm and telephone system; Benjamin F. Dillon, Savannah, Ga.

291,311 Telephone transmitter; Dan'l Drawbaugh, Eberlys Mills, Pa., assignor to the People's Telephone Co., of New York.

291,312 Telephone transmitter; Dan'l Drawbaugh, Eberlys Mills, Pa., assignor to the People's Telephone Co., of New York.

291,317 Underground telegraph system; Stephen D. Field, New York, N. Y.

291,318 Duplex telegraph; Stephen D. Field, New York, N. Y.

291,360 Railway block signal; John F. Knight, New York, N. Y., assignor to W. H. Baker.

291,371 Box for laying lines of telegraph wire; Thomas J. Mayall, Reading, Mass.

291,399 Conduit for electric wires; Nelson Randall, Jersey City, N. J.

291,405 Meter for electric circuits; Philip G. Russell, Washington, D. C.

291,435 Device for attaching cross-bars to telegraph poles; Christopher H. Wagner, Elkhart, Ind., assignor of one-third to William Kline, Toledo, Ohio.

291,445 Method of and apparatus for regulating the electrical transmission of power; Edward Weston, Newark, N. J., assignor to the United States Electric Lighting Co., New York.

291,463 Electric gas generator; Charles E. Ball, Philadelphia, and Charles S Bradford, Jr., West Chester, Pa., assignors to said Ball.

291,464 Support for filaments of incandescent lamps; Joseph S. Beeman, London, England.

291,465 Secondary battery regulator; Joseph S. Beeman, William Taylor and Frank King, London, England.

291,472 Telephone transmitter; Dan'l Drawbaugh, Eberlys Mills, Pa.

291,478 Sectional compound telegraph wire protector.

BUSINESS NOTICES.

BRUSH ELECTRIC CO., Cleveland, Ohio. Arc Lights and Brush Storage Batteries.

SWAN INCANDESCENT ELECTRIC LIGHT CO., New York. Incandescent Lights, and Complete Apparatus. Send for illustrated catalogue.

Armington & Sims, Providence, R. I. Engines for Electric Lighting and general use.

THE ELECTRICAL SUPPLY CO., New York. Electric Light, Telephone and Telegraph Supplies. Send for price list and catalogue.

CHARLES WILLIAMS, JR., Boston, Mass. Call Bells, Electric Bells, District Bells, Switch Boards and Annunciators, &c., &c. Write for quotations.

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LAW TELEGRAPH CO., New York. The Law Battery for Telephone and Telegraph purposes.

THE LONG ISLAND BRAIDING MACHINE CO., Providence, R. I. Braiding and Winding Machinery for covering all kinds of Telephone, Telegraph and Electric Light wire.

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B. W. PAYNE & SONS, Corning, N. Y. The Payne Single and Double Valve Automatic Engine. Send for catalogue.

LECLANCHE BATTERY COMPANY, New York. The Great Telephone Battery. Write for description and prices.

IVISON, BLAKEMAN & TAYLOR, New York. Ink of all kinds and colors. Circulars sent on application.

NEW ENGLAND BUTT COMPANY, Providence, R. I. Braiding Machinery for covering Telegraph, Telephone and Electric Light Wire, Single and Double Winders and Braiders of every description; also Fine Castings. Send for catalogue.

THOMPSON-HOUSTON ELECTRIC LIGHT CO., Boston, Mass. Automatic Self-regulating System of Arc Lighting.

STANDARD ELECTRICAL WORKS, Cincinnati, Ohio. Manufacturers of Telegraph and Telephone Instruments, Magneto Bells, Switch Boards and Telephone Exchange Apparatus, Annunciators, Wire, Batteries, Insulators, Electric Light Wire and Supplies. Send for circular and prices.

CHICAGO INSULATING CO., Chicago, Ill. The Fiske-Mott High-resistance Insulator. Send for circular.

SCHLEICHER, SCHUMM & CO., Philadelphia, Pa. Manufacturers of the Otto Gas Engine. Write for catalogue.

CHROME STEEL WORKS, Brooklyn, N. Y. Steel for Magnets a specialty: Chrome Cast Steel.

A. C. NORTHROP, Waterbury, Conn. Iron and Brass Machine Screws, Zinc in Sheets and Plate for Electrical Purposes, Parts for Telephone and Telegraph Instruments, Manufactured from Iron, Brass, Steel or Zinc.

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ELECTRIC GAS LIGHTING CO., Boston, Mass. Improved Electric Gas Lighting Apparatus.

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PAINE & LADD, Washington, D. C. Attorneys in Patent Causes, and Solicitors of Patents.

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No. 93,563	August 10, 1869	No. 194,328	August 21, 1877
No. 119,561	October 3, 1871	No. 199,676	January 29, 1878

Others pending.

SINGLE HAND GAS LIGHTING APPARATUS.

No. 116,054	June 20, 1871	No. 203,406	May 7, 1878
No. 146,953	January 27, 1874	No. 206,272	July 23, 1878
No. 152,427	June 23, 1874	No. 209,016	October 15, 1878
No. 177,459	May 6, 1876	No. 225,971	March 2, 1880
No. 180,832	August 8, 1876	No. 259,267	June 6, 1882
No. 180,833	August 8, 1876	No. 279,634	June 19, 1883
No. 202,694	April 23, 1878	No. 282,043	July 31, 1883
Re-issue No. 7,249	August 1, 1876	No. 290,732	December 25, 1883

Others pending.

Also for the States of New York, New Jersey and Pennsylvania.

No. 55,641	June 19, 1866	No. 230,567	July 27, 1880
No. 62,125	February 19, 1867	No. 230,589	July 27, 1880
No. 121,301	November 28, 1871	No. 230,590	July 27, 1880
No. 121,302	November 28, 1871	Re-issues 9,611, 9,709 and 9,846	

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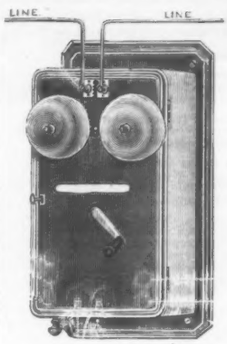

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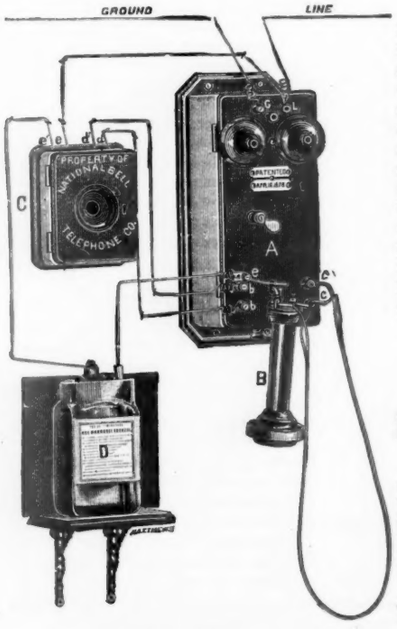

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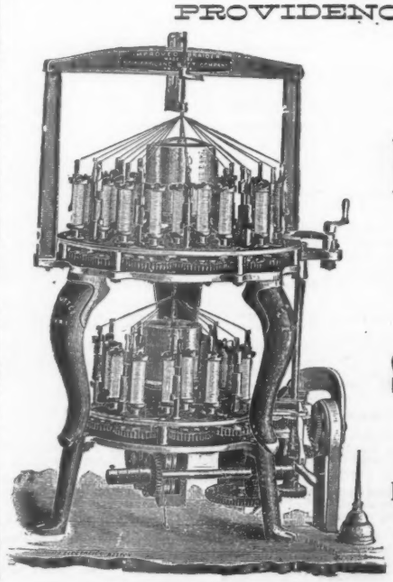

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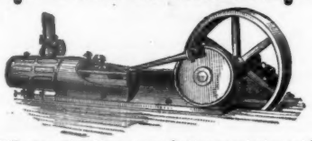

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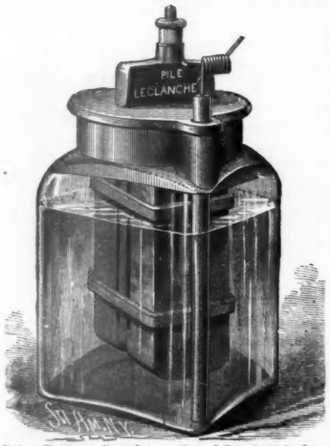

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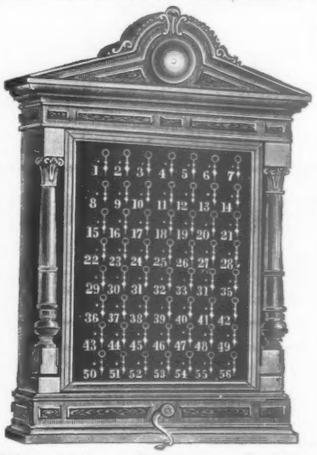

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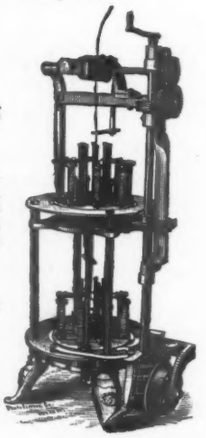

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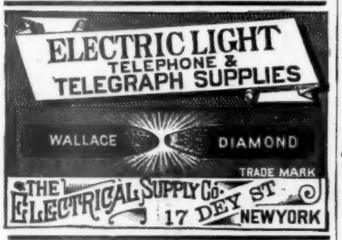

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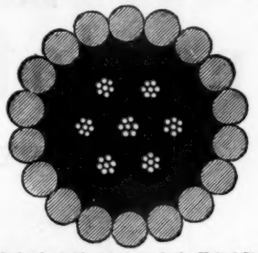

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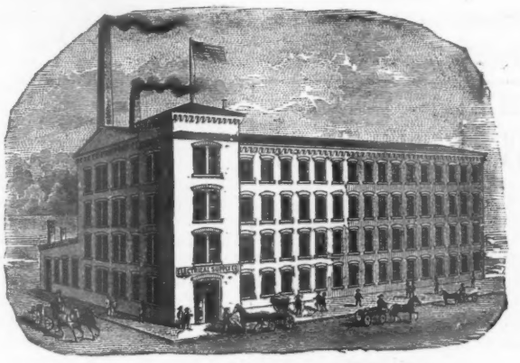

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